JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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PANAMA CANAL HYDROELECTRC DEVELOPMENT.

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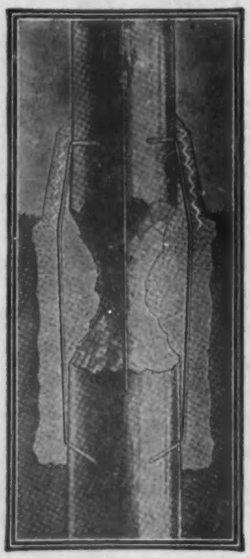

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POWER AND GAS
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THE SUPERB SOUTH GARDENS OF THE P. P. I. E.

In no part of the Exposition will the lighting be shown to better advantage than in the magnificent South Gardens which are flanked on the one side by facades of the various palaces and the huge Tower of Jewels, 435 ft. high and on the other by a wall of massed pink asters. At one end is the green and gray "stone" Palace of Horticulture with its immense glass dome radiant with reflected light-tones, and at the east end, the Festival Hall. The strains from the large organ in this building will fill the gardens with harmony throughout the day and night.

A feature of the illumination system of the Panama-Pacific International Exposition to be held in San Francisco in 1915, will be its apparent simplicity and the quiet refinement of its beauty. Garishness will be absolutely "taboo" and instead of millions of yellow, red and blue incandescent lamps being exposed to view, the palaces will be flooded with a pure white light while the gardens will be lighted by the rays of hidden searchlights.

At former expositions it has been the custom to outline the buildings with rows of incandescent lamps which eliminated the high lights and shadows and presented the appearance of strings of blinding light.

Under the flood-lighting system in use at the Panama-Pacific International Exposition huge standards have been placed along the walks facing each building and shielded by banners on all sides except the one opposite the facade of the palace. The light from these will throw the architectural features of the buildings into relief and the natural shadows will be accentuated by means of purple-dipped hidden lamps behind the pillars.

The South Gardens lie between the main group of exhibit palaces that face north upon San Francisco and the huge flowered wall that marks the boundary of the grounds upon the south. The site of the exposition extends east and west for a distance of fifteen thousand feet, almost three miles, and is located just inside the famous Golden Gate entrance to San Francisco harbor from the Pacific Ocean. The Exposition opens February 20, and closes December 4, 1915.

South Gardens and Main Entrance at Night.

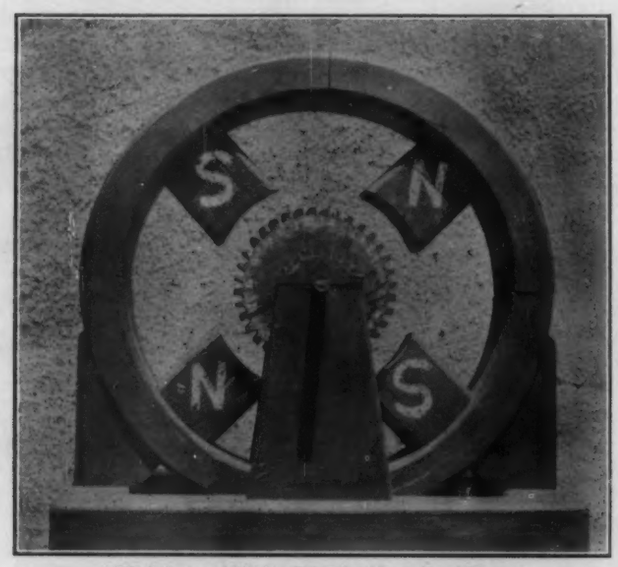
ELECTRICAL DEMONSTRATIONS.

BY ERNEST LEROY ARNOLD AND DAVID BEARD MUNROE.

(These demonstrations for class room work were presented as a thesis to the University of Southern California for the degree of Bachelor of Science in Electrical Engineering, and delivered as a paper at the last meeting of the Los Angeles section A. I. E. E. by the authors.—The Editors.)

This thesis was undertaken at the suggestion of Professor Nye and has been an endeavor to present by means of models demonstrations and suggestions some of the various fundamental ideas met with in the discussion of electrical subjects.

With this idea in mind a circular letter was prepared and sent to some fifty different engineering schools in the country stating the purpose of the thesis and inviting their co-operation in suggesting what they may have used along this line. In this manner we hoped to obtain several ideas to be worked out and constructed by us and put in thesis form. However, but little information was obtained and so we were thrown on our own resources and have succeeded in collecting the following demonstrations.



Model to Aid in Illustrating Problem.

This idea is a new one here and perhaps some of next year's senior class will take up the work where it has been left and, by noting the difficulties and setbacks encountered this year, be enabled to progress more rapidly and favorably until a very valuable and instructive collection can be gathered together. When this has been accomplished it is the purpose to publish the results in pamphlet form and distribute them among the colleges that they, as well as this school, may derive some benefit from this investigation.

The following pages contain the results of this year's work and as will be noticed has been divided under the head of Propositions. Each one is complete in itself although several can be intermingled and made to illustrate the same subject perhaps from a different angle.

The models have been constructed by the investigators themselves and several interesting mechanical difficulties had to be met before the ideas and theories could be applied mechanically and the model produced.

Proposition 1.

Number of windings possible. The object of this investigation was to obtain the largest number of windings that could be placed upon a convertible two and four pole model having originally 36 conductor slots and eighteen commutator segments. Also the various combinations possible using 34 conductor slots were worked out using same armature with two dummy slots, and using 17 commutator segments. A greater number of winding than here shown could be put on but only the windings which could be used practically were considered. Both front and back pitch must be approximately equal to **z/p** (where **z** equals number of inductor slots and **p**, the number of poles) in order that the two inductors which constitute a winding element may move simultaneously under field poles of opposite polarity. And so the front and back pitches were chosen to fulfill the following requirements.

(a) All the winding elements must be similar mechanically and electrically and they must be placed symmetrically on the armature core.

(b) Lap winding, the front and back pitch must be of opposite sign; they cannot be numerically equal as this would connect both terminals of a winding element to the same commutator segment.

(c) The total number of inductors may be any even number except in the case of slotted armature cores, in which case **z** must be a multiple of the number of slots.

The following results were obtained and the equations used appear above each set of front and back pitches:

Two-Pole.

Front pitch and back pitch must differ by two.
Front and back pitch must approximate Z/2 equals 18.

Front Pitch.	Back Pitch.	Re-entrancy.
17	—15	Single
19	—17	"
—15	17	"
—17	19	"

Four Pole.

7	—9	"
9	—11	"
—11	9	"
—9	7	"

Duplex Winding.

Front and back must differ by four.

Two Pole.

15	19	Double
17	21	"
—21	17	"
—19	15	"

Four Pole.

5	9	"
7	11	"
—9	5	"
—11	7	"

Triplex Winding.

Two Pole.

Front Pitch.	Back Pitch.	Re-entrancy.
13	—19	Triple
15	—21	"
17	—23	"
—19	13	"
—21	15	"
—23	17	"

Four Pole.

5	—11	"
7	—13	"
—11	5	"
—13	7	"

Wave Windings.

Front and back alike in sign may be equal or differ by any multiple of two, average pitch nearly equal to z/p.

Simplex.

Equation:

$$z = p\,y \pm 2$$
$$36 = 2\,y \pm 2$$
$$y = 17 \text{ or } 19$$

Two Pole.

Front Pitch.	Back Pitch.	Re-entrancy.
15	19	Single
17	17	"
13	21	"
19	19	"
21	17	"
23	15	"

Four Pole.

Equation:

$$36 = 4\,p + 2$$
$$p = 8.5 \text{ or } 9.5$$

No windings.

Duplex Wave.

Two Pole.

Equation:

$$36 = 2\,y \pm 4$$
$$y = 16 \text{ or } 20$$

17	15	Double
19	13	"
19	21	"
17	23	"

Four Pole.

Equation:

$$36 = 4\,y \pm 4$$
$$y = 10 \text{ or } 8$$

9	7	Double
11	5	"
9	11	"
7	13	"

Triplex Wave.

Two Pole.

Equation:

$$36 = 2\,y \pm 6$$
$$y = 15 \text{ or } 21$$

Front Pitch.	Back Pitch.	Re-entrancy.
15	15	
13	17	
11	19	
21	21	
23	19	
25	17	

Four Pole.

Equation:

$$36 = 4\,y \pm 6$$
$$y = 7.5 \text{ or } 10.5$$

No winding.

Assume Z equals 34. K equals Z/2 equals 17, commutator bars.

In lap windings they will be same as when 36 conductors are used, in Duplex and Triplex will be changed to single re-entrancy. But in wave windings the cases that could not be wound before, can with 34 inductors.

Simplex Wave.

Two Pole.

Equation:

$$34 = 2\,y \pm 2$$
$$y = 16 \text{ or } 18$$

17	19	Single
15	21	"
15	17	"
13	19	"

Four Pole.

Front Pitch.	Back Pitch.	Re-entrancy.

Equation:

$$34 = 4\,y \pm 2$$
$$y = 8 \text{ or } 9$$

7	9	Single
5	11	"
9	9	"
7	11	"

Duplex Wave.

Two Pole.

Equation:

$$34 = 2\,y \pm 4$$
$$y = 15 \text{ or } 19$$

15	15	Single
17	13	"
11	19	"
19	19	"
17	21	"
15	23	"

Four Pole.

Equation:

$$34 = 4\,y \pm 4$$
$$y = 7.5 \text{ or } 9.5$$

No winding.

Triplex Wave.

Two Pole.

Equation:

$$34 = 2\,y \pm 6$$
$$y = 14 \text{ or } 20$$

Front Pitch.	Back Pitch.	Re-entrancy.
13	15	Single
11	17	"
19	21	"
17	23	"

Four Pole.

Equation:

$$34 - 4\,y \pm 6$$
$$y = 7 \text{ or } 10$$

7	7	Single
5	9	"
9	11	"
13	7	"

The total number of windings that can be wound on model with 36 inductors and 34 inductors equals 92.

(To be continued.)

Electricity direct from coal has been produced by a German inventor, Johannes Marschall, of Dresden, who recently patented an application of the well known principle of the thermopile to the practical production of electric light without the intervention of boiler, engine, or dynamo. Nearly a hundred years ago it was discovered that two metals joined at one end and made hotter than the junction at the other end would generate a current of electricity through the metals. But the amount of electricity made by one such combination is always too small for practical use in lighting. The present inventon consists of a furnace containing a series of such thermopiles made of heat resisting metals, and is said to deliver a practical lighting current for a somewhat less fuel cost than the best steam engines. The first cost of the plant should also be considerably less. Elimination of the middle man, the favorite panacea for reducing the cost of living, is but an idle dream compared with the elimination of middle processes between coal, the original source of most of our power, and the usable power or electricity itself. There is a certain mathematical relation between heat and power, whether expressed as horsepower or kilowatts. If it were possible to turn into power all the heat contained in a pound of good coal it should theoretically produce 5½ h.p. or 4 kw.-hr. But in the roundabout way we now extract this power, we lose at every point, getting no more than 70 per cent of the total through the boiler, 30 per cent of this through the engine, and 90 per cent of the engine power into electricity, finally realizing in electricity less than one-fifth of the whole force of the coal, say three-fourths of a kilowatt hour. Thus there is a theoretical possibility to do five times as much with a pound of coal as is now being done.

PUBLIC POLICY OF PUBLIC UTILITY CORPORATIONS

ADVANTAGES OF COMMISSION CONTROL.

BY JOHN A BRITTON.

(In this article which was presented before the Civic Club, San Francisco, June 4, 1914, Mr. Britton points out some of the economic advantages of commission control and in doing so gives a brief history of the development of utilities.—The Editors.)

Public necessity produced public utilities. Public utilities as we know them today are of very recent origin and very young in years as the lives of men and nations are measured. It is but 104 years ago that artificial gas was first manufactured and distributed; 80 years ago since the first steam railroad was operated for public service; 50 years ago since the telegraph became an actuality; 30 years ago since the first introduction of telephones commercially.

Contemporaneous with telephones came the first introduction of electric lighting Electric lighting, however, as we know it today in the general use of incandescent lamps was not a commercial possibility until after 1890, but 24 years ago. The development of hydroelectric high tension long distance transmission dates practically from the year 1900, or but 14 years ago. Propulsion of street cars by means of electric motors reached its present state of excellence not over 20 years ago. It may, therefore, safely be said that not until the congestive conditions of urban and interurban life demanded it were public utilities more than a negligible quantity from both economic and utilitarian points of view.

The exploitation of public utilities in their initial stages called for comparatively little capital, and as the conveniences of these public utilities provoked continued increased uses, the public were willing to pay top notch prices for luxuries, even as they are disposed today to do in matters and things beyond the operations of public utilities.

From these rates as originally charged tremendous profits were derived, and the active financial minds of the earlier days taking advantage of public necessitics, or the desire for the new found luxuries, derived for themselves and their associates tremendous profits from the undertakings, for as the demand increased the necessity for greater amounts of money became apparent to meet the varied uses of all of the commodities furnished to the public, and to meet the great transportation problems of transfer of peoples and merchandise from one end of our nation to the other.

Opportunities were thus afforded to financiers in the great demand for money to meet the growth of population to create for themselves and their associates plans which would give to them an undue share of the tremendous profits existing, and therefore as the demand increased by the multiplication of peoples and the opening up of new territories, the burden upon the consumer became more and more apparent, until the cries of the consumers reached the ears of legislators, and then it became necessary for legislation to properly take care of the interests of the public being served by utilities.

The first positive legislation on the question of regulation in the United States originated in the state of Massachusetts, celebrated for its very conservative control not only of public utilities, but in fact control of all corporations doing business in that commonwealth. It made its way in a modest unassuming manner and, excepting to correct very positive evils, at no time exercised drastic control, nor has it up to the present time, excepting in the preservation of the integrity of the securities and properties of the utilities dominated by it.

Other states taking advantage of the Massachusetts law, and its splendid effect on the securities of corporations in that state, began to adopt similar laws, although modeled after more progressive lines and more corrective of evils, which were continually occurring to the prejudice of the public served.

Our own state of California was slow in following the lead of other states, although public service corporation men, seeing the good effect of same regulation in other states, were continually asking for the creation of a board of control. Unfortunately,the experience of early Californians with the railroad commission of this state did not give it the confidence that it should have in commissions to regulate corporations.

As early as 1890 I advocated, in the press in Alameda county, the creation of a commission to take care of public utilities other than railroads, and with such influence as I possessed endeavored to secure a state legislation to that end for years thereafter. The time, apparently was not ripe and efforts failed. These efforts were predicated upon the unsatisfactory conditions arising from the constitution under its provisions as adopted in 1879 and amended in 1884, wherein by Article XI, Section 19, full power was given to all utilities to operate in cities without any grant of franchise other than the constitutional grant, and subject only to the provision that the governing body had the right to fix the rates. There were very few of the governing bodies that assumed that prerogative, perhaps due largely to the fact that rates were not exorbitantly high, and competition became more and more positive, although as a rule detrimental and destructive. There was a maintenance generally until about 1900 of high rates in electric service, until the production of cheap oil in quantities about that time made possible reduction in the price of steam generated current and of gas without any very great reduction in the profits, and matters lay dormant.

In the year 1907, in a paper read before a technical society on the Pacific Coast, I advocated very strongly corporation regulation. I quote from the paper read:

The day has gone into the night of darkness when reasonable far seeing and deep thinking corporation men object to the proper regulation of corporations. Regulation is needed for protection, for without it each corporation will be at the mercy of as pitiless a pack of howling destroyers as would a lonely traveler on the Siberian steeppes be against a band of gaunt and hungry wolves. Aggregation of wealth centralized becomes too great a power for evil to be permitted to exercise its own prerogatives. Commissions created in the states of Massachusetts, New York and Wisconsin have restored confidence in corporations, and have restored the confidence of investors in that they set the mark of peace on the distracted brows of the public, and have made it possible to insure an earning capacity on money invested.

This was over five years before regulation was secured.

Aside from the feeling that corporation regulation was a necessity, was the feeling that the existing method in California was ineffectual in regulation of prices for services. Committed to the tender mercies of a board of supervisors or a board of trustees or council, the companies had to face petty grafting, local political situations, and trust affairs involving millions in the hands of men whose understanding was limited to relation of cents and not millions. The hearings had before governing bodies of the various municipalities of any valuation of property or any proper rate of return were very loosely and arbitrarily determined upon, and gave rise to graft, dishonesty and dishonor.

In the hands of an appointed body of men equipped with forces to legally, technically and scientifically work out the problems presented, there is a greater certainty of a conclusion being arrived at in an orderly, legal and logical way than by any other means. The technicalities of court trials, to which utilities have been driven by the confiscatory findings of municipal bodies, are done away with in the court of the common people called "regulatory bodies."

The reason why the public utility man who desired only justice in the protection of his property is in favor of regulation, is covered by the above reflections on past methods of non-regulation, but there are greater and stronger principles involved.

A public utility cannot out of the surplus of its earnings provide sufficient capital for the extensions required in any growing community. It must look to the world at large for such money as may be necessary. The people who supply this money are known as investors, and they need, much more than the utility actually needs, the protection of regulation. What blood is to the body, that capital is to the utility. A healthy flow of blood makes life, vigor and growth; to the utility it makes all these things, with good service to the public and employment for the artisan and laboring man. Reversed, an anemic condition results, destructive, to the body politic and body corporate.

The new investment of money in a growing territory never ceases. In our own enterprise in 7 years the company has taken over 166,000 new consumers, and spent a total of over $34,000,000, or about $210 per consumer.

Reverting to the investor, he is a free agent in the disposition of his capital, and it must be coaxed and reasoned out of his pocket. With thousands of other utilities and business enterprises coaxing and reasoning at the same time, the far away voice of the California utility must make itself heard in the general clamor for money, and unless it strikes the key of confidence in the investor, its siren song will be of no avail.

The railroad commission of the state of California has done in two years more to inspire the investor with confidence in California securities than all of the gilt edge promises of promoters in the years past, and more than the attraction of the added intangible investment in the way of stock bonuses and bonds offered delivered in the past at the sole cost to the promoter of only printer's ink. The commission, in common with all other commissions, has taken the stand that the money of the investor, as long as it behaves itself and is devoted to the public good, shall and must be protected against reckless and improvident competition.

Public utilities are vastly different from those who dispose of merchandise. If the merchant is confronted with unlivable conditions he can load his stock into cars and move to other places. A public utility, once having taken up an abode must abide by whatever happens to it. It can under proper regulation be allowed to earn only a fair rate of return. The public may profit temporarily from competition between two utilities, but if unrestrained competition is permitted, one or both must go to the wall.

The prevention of such contingencies and destruction of capital is one of the greatest works of a commission and of regulation, and I am happy to be able to say that it has been the dominant note of the commission of this state. While it may take some education to impress the people with the fact that the commission is working to the ultimate profit of the consumer, it is bound to be realized here as it has been elsewhere under honestly directed efforts.

There is no question but a regulated monopoly is above all things the only factor that will inspire investors with confidence, and it is up to the commissions having chage of regulation to create that inspiration. There can be no certainty that one corporation management may continue during the life of securities offered, so as to insure the integrity of the same. Regulation under commission form is a certainty that management will continue the same, because it so regulates the issuance of securities, etc., as to prevent mismanagement.

The requirement of the commission that detailed explanation should be made of all requests for expenditures of capital, and with that the submission of plans and estimates, are provocative of careful consideration of investments before submission to such a scrutinizing body. The commission holds in that respect the position of trustee to the investor, and safeguards his interests by an earnest and unprejudiced consideration of the needs and wants of the community as reflected by the expenditure of the corporation, and is a guarantee beyond any question of the honest expenditure of funds so allowed.

Recent disclosures of the affairs of one of our largest railways clearly indicate the necessity for safeguarding the application of capital and the Eastern railway system under the proper regulation which should have ensued could not have paid $11,000,000 for property worth only $5,000,000.

Careful consideration in regulation goes in the survey of accounts of utilities, and aside from seeing that capital accounts are not overcharged, makes an adequate provision for maintenance and depreciation.

There is not a manager of a public service corporation in this or any other state who honestly administers his property, but should encourage and defend the policy of state regulation over his business, so that in the end not only his corporation, but the public, will be adequately, efficiently and honestly served, and with the confidence that must come from the public to the commission, so will confidence in the public utility serving the people be reflected.

P. P. I. E. MACHINERY EXHIBITS

THE G. E. HOME ELECTRICAL.

An attractive feature of the General Electric Company's large exhibit at the Panama-Pacific International Exposition, which will be held in San Francisco next year, will be the "Home Electrical," occupying a conspicuous place in the Manufacturers' Buildings. Besides adopting all the practical ideas previously used in various electrical houses for exhibition purposes this model home at the world's greatest exposition will be the first of its kind to be specially designed and built for the purpose by a skilled architect. It will be an electrical home in every sense of the word inasmuch as the exhibit will include the electrification of the house, garage, workshop, laundry, creamery, etc. All the practical electrically operated labor saving devices suitable for use about the home will be shown in actual service. The "Home Electrical" be a full sized house, of the attractive California-Spanish type, much the same as the Western home of an American family of moderate means. It will consist of a living room, a dining room, breakfast room, bedroom, bath, kitchen, laundry and sewing room. Nearby will be located the electrical garage, the workshop, creamery, etc. The rooms will be suitably decorated and attractively furnished. The plans call for an interior arrangement along the most approved modern lines designed to make housekeeping easy, so the necessary work can be done without wasted effort or lost tiime. Each room will be equipped with practical labor saving and comfort promoting devices operated by electricity.

The electric wiring of this building will be along the most approved lines and the electric lighting will be entrusted to an illuminating engineer. The Mazda lamps will be installed to give an even distribution of light in all parts of the house with no wasted energy, no dazzling flame points, no brilliant glare or heavy shadows.

The kitchen, where most of the housework is accomplished, will be provided with an electric range for all cooking purposes, and with electrically driven machines for peeling vegetables, polishing silver, freezing ice cream, driving cake and dough mixers and doing other necessary work. In the electric laundry the clothes will be washed by electric power and ironed with electric flatirons. In striking contrast the adjoining room will have an electric refrigerating plant of household size where the same form of energy used for heating and cooking will produce low temperatures for preserving food stuffs and for making artificial ice.

The dining room will be arranged to show how light lunches and suppers can be cooked with the electric chafing dish, or the electric grill, on the table if desired. This same cooking equipment may be utilized for preparing the morning meal in the adjoining breakfast room. The sewing room will be equipped with a motor-driven sewing machine, a small fan and an electric pressing iron suitable for attaching to the light socket. Even the bedroom will have its modern electrical appliances—a small fan, electric lights, heating pad and baby milk warmer.

In connection with the Home Electrical, and as a part of the exhibit, will be shown a garage with an electric runabout, battery charging outfit, etc. Adjoining the garage is to be located a small work shop, completely equipped with electrically driven tools. And, for the benefit of those who live outside the cities and larger towns the use of small motors on the country place will be illustrated by a model dairy room with cream separator, churn, bottle washers, water pumping station, and other small motor-driven machines such as are used almost daily on every country place.

THE NEW LONDON SHIP AND ENGINE COMPANY.

One of the interesting features of the machinery exhibits will be found to be that of The New London Ship & Engine Company of Groton, Conn.

The exhibit of the company will consist of one 180 h.p. six cylinder, four cycle, single acting, heavy oil engine, working on the Diesel principle, and the engine will be direct connected to some mechanical appliance for absorbing power, such as a pump or generator.

The bore and stroke are respectively 9 and 12½ in. and the normal revolutions 350, at which speed the engine develops slightly over 180 h.p.

The starting of the engine is obtained by means of compressed air with starting attachments on three cylinders. As soon as started the remaining three cylinders begin to fire on oil after which, when the starting gear is thrown out, the other three cylinders also begin to operate on oil.

Governing is obtained by means of centrifugal weights placed in the flywheel and controlling the fuel pump through a series of mechanisms.

An air compressor is placed on the forward end of the engine and is used to supply air for spraying the fuel into the cylinders, and for storing air for starting purposes.

This compressor is driven by a crank on the main crankshaft, and has two compressing stages in tandem. It compresses up to 1000 lb. per sq. in. Two camshafts are used, one on either side of the engine geared to the main shaft. Large size cams are used for operating levers transmitting the motion to the valves. The cylinders and head are cast in one, with the valve chests for the inlet and exhaust valve arranged horizontally. The spray valve is vertical. This arrangement of head gives an ideal form for combustion, and also ample area for valves.

The circulating water for this engine is supplied by either a plunger or a centrifugal circulating water pump. The lubrication for all bearings is obtained by the mechanical lubricators attached to the engine.

Visitors to the exhibition will thus be able to see the engine in operation, and as there will probably be Diesel engine plants of other makes running at the same time, to compare the relative features of each different design.

OFFICIAL CLASSIFICATION OF P. P. I. E. MACHINERY EXHIBITS.

(Concluded.)

Class 454. Condensing apparatus: surface and jet condensers; air pumps, dry vacuum pumps, circulating pumps; cooling towers, cooling systems.

Class 455. Methods and appliances for testing and recording the performances of engines, turbines, boilers, condensers, their auxiliaries, and other machinery: pyrometers, steam thermometers, calorimeters,t steam meters, CO_2 recorders, flue gas analysis apparatus for steam power plants; counters, gages, indicators, tachometers, and dynamometers.

Internal Combustion Motors.

Class 456. Internal combustion engines, gas turbines, and all motors in which internal combustion of the fuel takes place; apparatus and systems for supplying fuel for internal combustion motors.

Note:—This group does not include motors attached to mobile devices (such as automobiles), nor does it include agricultural or road making machinery.

Hydraulic Motors.

Class 457. Impulse wheels, turbines and other motors driven by water power, and apparatus for their regulation and control.

Class 458. Motors operated by heated air, or other means, not elsewhere classified.

General Machinery and Accessories.

Class 459. Appliances for handling heavy weights; overhead traveling and stationary cranes, operated by hand or power; hoisting engines, jacks, differential pulleys. (Marine and mining equipment not include.)

Class 460. Conveying machinery; belt, bucket and movable table or roller conveyors; trolley conveyors. (For special apparatus in mining see Classes 750, 756 and 780.)

Class 461. Power-transmitting appliances; leather, fiber, chain, link and other belting; cable and rope drives; gearing, shafting, couplings, pulleys, clutches, hangers and pedestals.

Class 462. Apparatus for lifting and handling water and other liquids: hand, steam and power driven pumps, pulsometers, air lifts, hydraulic rams; water pipe and accessories; water meters. (See also Classes 451, 470, 530, 554, 559 and 751 for pumps for special uses.)

Class 463. Fire engines, extinguishers and fire fighting apparatus. (See Class 183.)

Class 464. Air and gas compressors and accessories. (See also Classes 354 and 749.)

Class 465. Brick and tile making machinery. (Transferred to Class 765.)

Class 466. Dredging and excavating machinery and appliances. (For railroad machinery see Class 520. For mining machinery see Class 759.)

Class 467. Refrigerating machinery. (See also Classes 531 and 601.)

Class 468. Packing, gaskets, heat insulating material, lubricators, lubricants, lubricating systems, metal for bearings.

Class 469. General machinery not otherwise classified.

Tools for Shaping Wood and Metals.

Class 470. Steam forging hammers, hydraulic forging presses; hydraulic accumulators, intensifiers, pumps and accessories; extruding presses; hand and power shears, punches and blank cutters for metals; plate bending and planing machines; drop forging hammers; swaging presses; riveting machines. (See Class 462.)

Class 477. Special machinery for various purposes, not otherwise classified.

ELECTRICAL GROUPS.

Commutating Apparatus.

Class 478. Direct current commutating generators, all types.

Class 479. Synchronous commutating machines, comprising synchronous converters, motor converters and double current generators.

Class 480. Direct and alternating current commutating type motors.

Class 481. Direct and alternating current commutating type railway motors.

Synchronous Apparatus.

(All alternating Current.)

Class 482. Synchronous generators, all types.
Class 483. Synchronous motors.
Class 484. Synchronous condensers.
Class 485. Synchronous frequency changers.
Class 486. Synchronous rotary phase converters.

Stationary Induction Apparatus.

Class 487. Transformers (including induction coils) and autotransformers, all types.
Class 488. Potential regulators and reactances, all types.
Class 489. Induction starters.

Rotary Induction Apparatus.

Class 490. Induction generators, all types.
Class 491. Induction motors.
Class 492. Induction condensers.
Class 493. Induction frequency changers.
Class 494. Induction rotary phase converters.

Unipolar (Acyclic) Apparatus.

Class 495. Unipolar (Acyclic) apparatus.

Rectifying Apparatus.

Class 496. Rotating commutators.
Class 497. Electric valves (including mercury rectifiers.)
Class 498. Vibrating commutators.

Luminous Apparatus (Sources of Light.)

Class 499. Arc lamps, all kinds.
Class 500. Incandescent lamps, all types.
Class 501. Vapor lamps, all types.
Class 502. Vacuum lamps, all types.

Measuring, Indicating and Recording Apparatus.

(Not including instruments for pure science and research work.)

Class 503. Instruments for switchboard use.
Class 504. Instruments for mounting apart from switch board.
Class 505. Portable instruments.
Class 506. Laboratory instruments.

Apparatus for Protection of Electrical Apparatus and for Control and Distribution of Electric Energy, Other Than Railway Material.

Class 507. Complete switchboards.
Class 508. Lightning arrestors and accessories.
Class 509. Devices for opening and closing circuits and controlling flow of current therein.

Note:—In class 509 will be placed such devices as are used in stations and on main circuits.

Class 510. Devices and material used in distribution of current and control of distribution circuits other than in stations and on main circuits; including fuses and fuse holders, conduits, cables, wires, insulators, junction boxes, cabinets, cut-outs, sockets, fixtures, electric sign mechanism, and other subsidiary apparatus not otherwise classified. (See Class 308.)

Class 510½. Electrical workers' tools and appliances.

Electro-Chemical Apparatus.

Class 511. Storage batteries.
Class 512. Primary batteries.

LIGHTING METHODS

THE LIGHTING FIXTURE SITUATION.

BL CHAS. G. BAILEY.

(This article which presents ably the lighting fixture situation also contains many suggestions for the way out from present difficulties and undesirable conditions with the promise of raising the lighting fixture business to the plane of a profession.—The Editors.)

What is our business coming to?

Perhaps in no field of endeavor does one hear this question raised more often than in the lighting fixture business. The poor retailer seems the helpless pawn of a fate which yesterday meant the introduction of the tungsten lamp, today is the glass manufacturer with a bewildering array of attractive offerings and tomorrow—ah, if you and I were only sure just what was to be, wouldn't we quickly throw the sheet over the humble remains of yesterday and today and strain our credit and the capacity of our show rooms in order to acquire the thing which our friends the buying public will recognize as "the latest."

Speaking seriously, was there ever a business so full of rainbows and rainbow chasers? You know how elusive it all is. The show rooms are filled with the type of things which we are certain the public will buy —only they do not buy all of them soon enough. Then the next wave of enthusiasm breaks and in the foam on the beach, which marks the uttermost effort of the latest by someone, we see the sort of thing we and the public have long wanted. So it goes and the end is not yet.

Is it not time the Eastern manufacturer of metal and glass, the importer, the jobber and the retailer took counsel together. Who or what is to solve this unsolvable question? Can the number of Eastern manufacturers he lessened and kept down? Can the importer also be curbed? Can the profit of the retailer —enough for five say, but never for the twenty-five— be brought up to former high water marks?

Let us consider this situation in detail. Now if ever is the time ripe for a solution. At all times the retailer is the key to the situation. He it is who must dominate. He it is who must decide who shall continue to exist. Let the Eastern manufacturer be made to realize that sound credits are the basis of a healthy prosperous industry. Cause him to realize that before considering the account of a new lighting fixture firm he must know the experience and record of the man or men about to begin, and whether such an addition in that town is advisable.

The retailer looks and feels like a weak link, does he not? However, all is not lost. We cannot all start studios, but we positively must realize that we cannot be efficient in this day and age and continue to manufacture (?)—Heaven save the mark—any sort of fixture called for, from a cord drop to a bronze lobby-piece.

First decide whether you expect to go in for volume or art. Next stick to your decision. Then decide the same thing once more in precisely the same manner. Next stick to your second decision. Repeat this at frequent intervals for some time—we lighting fixture people have been in the habit of changing our honest-to-goodness set policies every few days or weeks, so it will take practice to make all these decisions come out alike. Then decide whether you expect to manufacture or buy ready made.

In case you decide to manufacture your own lighting fixtures, no one will object seriously if you first cancel this decision before finally deciding not to do so. If you experience any hesitation over this point, remember that, if you buy a thing from some one else which does not sell, you have a victim to roast, while if you have concocted the effusion yourself—but why go further?

Now that you have decided to buy your goods remember your decision to go in for volume or art, not both mind you, and buy where either the one or the other may be had. Right here comes your second lot of decisions. How many factories can our Western country support in addition to the many well organized and well equipped ones in the East? Not as many as you think—not by one-half. We haven't the population in the first place and we have the parcels post, express and freight in all the other places. Granted that you, Mr. Retailer, have decided just how many Western manufacturers measure up to this new scheme, because of proven worth and honesty in the past, it now becomes necessary for you to support these few to the limit—their limit and yours. Get a sign printer to print the definition for loyalty on the wall of your bedroom, come home early and spend some time each night in contemplation—in that room. How many times have you continued to purchase a popular seller from the same manufacturer, unless you had first proven to your own satisfaction that he was losing money on every one he sold to you?

A final point to remember—do not try to be too original. There is too much danger that one will become a purveyor of freaks rather than a seller of harmonious pieces. Restrain yourself if possible from attempts to make over every fixture offered you by the manufacturer. This will have a tendency to inculcate respect for the ideas of others and will eventually wear off the keen edge from that desire so long rampant on the Pacific Coast to create everything for oneself. After a time, with an instilled toleration, one can commence to suggest and adopt modifications which represent creative individuality. Then when one has finally learned to work easily from illustrations or photographs the final stages of the change have been reached. For we must learn, as a result of the kaleidescopic conditions of the lighting fixture business, to work less from stock and more from our catalogs. Strange as it may sound the more of this we do the higher grade of appreciation do our clients attain, while we at the same time approach our ultimate goal, keeping the profits of our business in the bank rather than in the show rooms, and broadening our business to the plane of a profession.

INVESTIGATION OF INDUCTIVE INTERFERENCE.

BY F. E. PERNOT.

(The author defines the terms used, outlines the theory of induced disturbances, and proceeds to discuss the normal interferences found as developed by the investigation of the joint committee dealing with this problem and appointed by the California Railroad Commission. This article is from a recent issue of the California Journal of Technology.—The Editors.)

A matter of more than passing interest to a large number of present day engineers, and one which is insistently demanding a solution, is that of inductive interference. Considered by itself, it is a subject which is not new—an understanding of the fundamentals involved having come coincidently with the theoretical and experimental researches of the early scientists. The problem now is a very practical one, brought about by the ever increasing complexity of the electrical installations demanded by a growing civilization.

"Inductive interference," in its broadest sense, can be understood to refer to the fact that the electrical conditions in any conductor or circuit are dependent to a greater or lesser extent upon the electrical conditions in an adjacent circuit. Considered in this way, the term might refer to many things—radio-telegraphy, the mutual action of solenoids, the effect of one wire of a three-phase transmission system upon the remaining two, and so on through both electromagnetic and electro-static conditions. In the narrower applications, this term refers to the harmful disturbances occasioned in signalling circuits by neighboring electrical activities. Ninety-nine per cent and over of "neighboring electrical activities" would, at present, be covered by saying power transmission systems. Theoretically the situation is a mutual one—the signalling circuit affecting the power circuit in the same way as the power circuit affects the signalling circuit, but when one considers relative magnitudes it requires no great effort to see that though in one case the effects are very serious, in the other they are entirely negligible. A power transmission line carrying a current of tens or hundreds of amperes at a potential difference of thousands of volts will have relatively a far greater effect upon a signalling circuit carrying only millionths or thousandths of an ampere of current at a potential difference reckoned in single volts, than will this signalling circuit have on the power system.

Due to the fundamentally sensitive apparatus used in the transmission of articulate speech—the telephone—this type of signalling circuit is subjected to by far the greatest inconvenience from electrical disturbances arising from any cause. Telegraph circuits, and in a lesser degree, railway block signalling systems are also affected.

Concerning inductive interference, then, the main interest centers around the matter of the introduction, from power distributing systems, of disturbances into telephone systems. Such interference can be broadly divided into two classes. First, those cases in which continuous and normal operating conditions of the power system render unsatisfactory a conversation carried on over neighboring telephone circuits, usually by the production of foreign sounds in the receiver; and, second, the cases in which abnormal or transient conditions of the power system render conversation impossible or endanger central office apparatus and even the operators in charge. These two cases do not occur singly; a telephone line so situated as to be affected in one case naturally is not entirely exempt in the other.

A brief outline of the theory of the induced disturbances is in order here. Induction arises from two principal causes—the electromagnetic and electrostatic fields—both of which make themselves apparent by the production of an extraneous current in the telephone circuit and therefore in the receiver.

The electromagnetic induction arises from the magnetic field set up by the currents in the power conductors. A portion of the magnetic flux produced by these currents links itself with the telephone circuit, and an electromotive force is generated therein proportional to the time rate of change of this flux. The power and telephone circuits are simply coupled by the mutual inductance of the circuits. This coupling is very "loose" due to the usually great separation, and the effect of small currents induced in the telephone circuit upon the power circuit is negligible. The currents are the result of the e.m.f. produced by the varying flux.

The phenomenon of electrostatic induction is due to the potentials of the power conductors. Surrounding the power conductors there exists an electrostatic field, and the potential of any isolated particle in the surrounding space is determined by the potential of the electrostatic field at this point. This is readily perceived when one recalls the numerous illustrations of the system of equi-potential lines surrounding a charged body. The potential of any point is determined by the equi-potential line passing through it. The two telephone wires comprising a circuit are at different positions in space and therefore, in general, are on different equi-potential lines as established by the power conductors. Consider now the situation which exists when one or both ends of the telephone circuit are connected through apparatus. The tendency then is for both wires to assume the same potential, but they can not do this without having established on them charges, or stored quantities of electricity, of a magnitude sufficient to alter the original field to the extent of placing the two conductors on the same equi-potential line. Since the power line potentials are alternating, the field is continually changing, thereby requiring changes in the charges necessary on the telephone conductors to maintain both at the same potential. These variations in charge constitute a flow of current through the connected apparatus, which then manifests itself in the same manner as a current produced by the e.m.f. of electromagnetic induction.

So much for the general theory, which, when founded on previously established physical laws is eminently simple. The mathematical problems involved become complicated when a rigid quantitative solution is desired relative to any particular case of "exposure"; but it is not this which offers the greatest difficulties. To make such a solution would necessitate the exact specification of all conditions involved by the entire system, and it is here that the matter passes beyond the possibility of mere theoretical treatment. What

are the conditions existing? What are the more general conditions which may be expected in typical cases, and what details are to be considered important and what unimportant? What can be done by the power companies and what can be done by the signalling companies to relieve already bad situations or to prevent the creation of new ones? To answer these questions which had become prominent through numerous complaints on the part of various signalling companies, a committee was appointed by the California Railroad Commission, under the title of The Joint Committee of Inductive Interference, composed of representative power and signalling engineers. It was to be the work of this committee to outline and have carried out the necessary tests to furnish material sufficient for a basis for decisions by the commission. The actual work was then placed in the hands of a testing force working together with a sub-committee on tests.

An investigation of the problem, on a scale far more extended than that of any previous work was then undertaken, work actually beginning in the last few months of the year 1912. The entire matter being pioneer work naturally required the expenditure of the greatest portion of the time on the developing of methods of procedure and in orientation—that is, in a selection of the limited number of things which could profitably be done from the unlimited number which presented themselves.

So far, it has been found, as expected, that in regard to continuous disturbances under normal operating conditions the greatest portion arises from the higher harmonics or multiples of the fundamental frequency existing in the power line currents or voltages. This is natural when one remembers the greater inductive action of high frequency currents or voltages, and also (within certain limits) the greater sensitiveness of the human ear to sounds having a frequency of vibration much higher than the customary frequency of 60 cycles per sec. Great complications in the investigation are introduced by this fact. Meter readings which indicate merely average or effective values of the current or voltage waves cannot be relied upon as giving full information. A few milli-amperes of current will give the same meter reading for one frequency as another, but the effect of equal currents in producing disturbances to conversation is a function of the frequency when used with the same receiver. The use of the oscillograph, an instrument to visualize and record photographically the actual wave shape as made up of its component harmonics, becomes necessary both in the determination of the induced currents in the telephone circuit and of the currents and voltages existing in the power system. The oscillograph, however, has its limitations in that its sensitiveness is not sufficiently great. Currents of the value of from 5 to 75 milli-amp. are required to operate it and this value of current is many times the current required to produce disturbances in a telephone receiver.

To detect, pick out and measure higher harmonics of these small magnitudes, a special scheme termed a "resonant shunt" has been resorted to. By its use, currents of a single frequency are selected by tuning in the same way as is done in a wireless receiving set. The magnitudes are derived by comparison of the volume of sound produced by the resulting single frequency current of unknown value with the sound produced by a known amount of current of the same frequency, supplied by a variable frequency apparatus—the Vreeland Oscillator. A disadvantage of this method is its slowness and the fact that a wave analysis by this method does not give a simultaneous determination of all the hamonics. However, it is the only scheme which appears feasible for such small currents.

A prolific source of trouble has been found to lie in the so-called "residual" currents or voltages. The residual current is defined as the "vector sum" of the line currents in the power system. Normally, this current would be zero—the current flowing outward in one conductor being returned by the others. In some conditions this may not be true—some of the outgoing current returning by way of the earth. This unbalanced portion of the current is much more effective in producing certain disturbances than are the currents which are balanced. The same way with the residual voltage which is defined as the "vector sum" of the line voltages to earth. Normally, this would be zero, one line potential being as much above earth potential as the sum of the others is below. Due to unbalances in the system this may not be true, and therefore the sum total would not be zero. The amount remaining, termed the residual voltage, has a relatively greater effect on adjacent circuits than do the balanced voltages. The accurate determination of these residuals is a matter of difficulty, due to their generally small magnitudes as compared with the totals involved. For example, the residual voltage of a 55,000 volt transmission line may be in the neighborhood of 100 or 200 volts; and, further, is generally of such variable magnitude as to render unsatisfactory measurements made at different times. The same applies to the residual current.

In order to determine fundamental data as regards the effects of these residuals, the power line is shut down, all three conductors connected together, and the whole then operated as a single conductor with ground return. In comparing the results of tests under such conditions with theoretical computations, large discrepancies were observed. The calculations, as originally made, were on the basis of the earth being a body of perfect conductivity which is equivalent to saying that the current returns entirely along the surface.

Working backwards, and computing the depth of the return current from the observed test data, the equivalent path of the earth return was found to be several hundred meters below the surface. While this is true for the return current, and therefore of importance in determining the electro-magnetic induction, just the reverse seems to be the case for electrostatic induction. The effect of trees, fences, towers and adjacent circuits is to exert a shielding influence which raises the equivalent earth plane nearer to the power conductors. Naturally, these two conditions are dependent entirely upon the character of the country in which the lines in question are located. This matter alone is sufficient to make unreliable any theoretical calculations of induction on new cases of exposure.

If the power system be an isolated one, the wave shapes of current and voltage will be fairly constant,

depending only on the generator supplying power and on the load apparatus. Such a case would be relatively simple of treatment as long as the same apparatus was used. However, in an interconnected system in which power is supplied by many generators in different stations, and where the character of the load is continually changing, the wave shapes are different at different times during the day. Even though all generators supplied pure sine waves, of, say, 60 cycles frequency, every piece of synchronous load apparatus present on the line would impress on the circuit such higher harmonics as were inherent in the apparatus itself. Since it is the higher harmonics which are of importance in the production of noise by induction, the complexity of the investigation work becomes apparent.

It has been found that even such inert apparatus as transformers contribute their share toward a distortion of wave shape. Impress a pure sine wave of voltage on a transformer and the current taken for excitation is not of a pure sinusoidal shape. This is due to the varying permeability of the iron core at different flux densities and is more marked the nearer the iron approaches saturation. In some cases a reduction of the flux density in the core (either by decreasing the voltage or by increasing the number of turns), as by five per cent, has affected a much greater percentage decrease in certain harmonics found present in the power line residual currents or voltages.

At the present time much study is being devoted to the subject of transpositions, both of the telephone and power circuits. By a proper scheme of relative transposition of both power and telephone conductors, the magnitude of induced disturbances can be greatly diminished and it is toward general methods for selecting the proper scheme that the study is directed. This subject is, in itself, fully as complicated as many of the previously mentioned matters. It is hoped that much can be accomplished towards an elimination of a large amount of the disturbance, occurring during normal operation, in this way.

From an investigation of the sort now going on nothing but good can follow and though the work necessarily proceeds slowly, the difficulties arising should be fully appreciated. The writer had, for some time, the opportunity of engaging in the work that is being done and can say that the whole subject is one of absorbing interest, both practically and theoretically.

A flying train is creating much interest among engineers and government officials at London, Eng. The model consists of a miniature car weighing some 40 lb., constructed of steel with an aluminum base, resting upon about 30 ft. of special track. Beneath the rails are electric coils which, it is explained, when energized by an alternating current, exercise a repelling effect upon the car sufficient to raise it a fraction of an inch above the rails. When thus suspended in the air, the car is drawn along by electromagnets, or solenoids, which span the track in the form of arches, through which the car passes. Although the model is raised above the track, four brushes attached to the car remain in contact with the rails and two other brushes make contact with an overhead grooved rail.

ELECTRICAL RESEARCH AT TECH.

The activities in electrical engineering research at the Massachusetts Institute of Technology have developed very rapidly during the past year and a noteworthy extension of the organization for administering the researches has recently been effected. This has been aided by the co-operative agreement between Harvard University and the Institute of Technology whereby the departments of electrical engineering in the two institutions were practically merged.

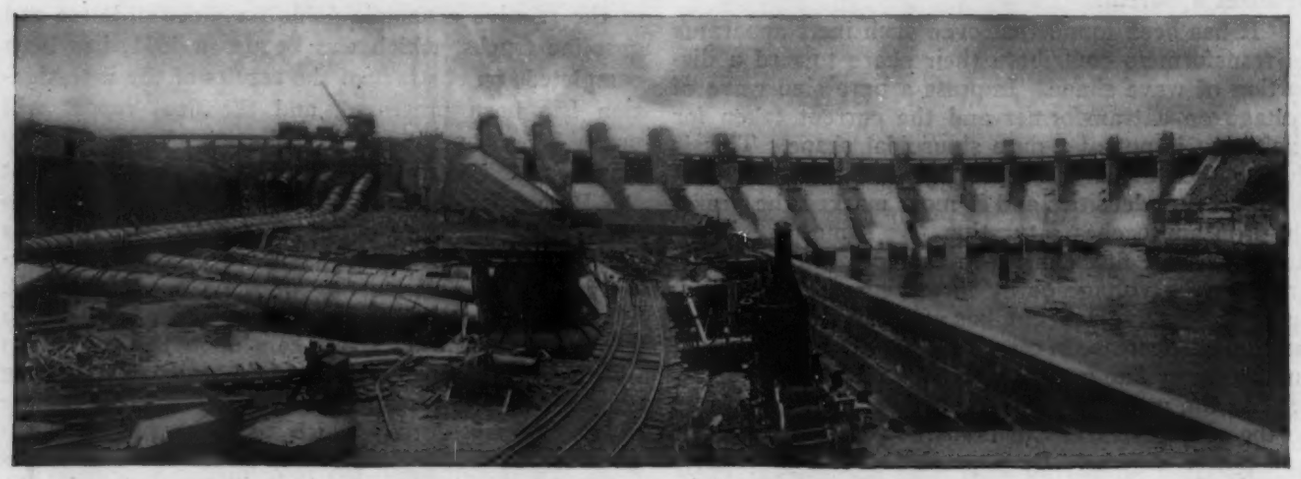
The study of a wide variety of problems has already been undertaken by the laboratory. During the past year, the collection of data upon the study of the relative economic fields for electric, horse and gasoline trucks, which was begun in 1911, has been completed; an abstract of the results of the investigation has been presented, and the final report will probably be completed early this summer. The study of the methods of handling miscellaneous freight at the Boston freight terminals, begun late in 1912, has been completed, and a paper covering the methods and results of the study has been prepared for presentation at a fall meeting of the New York R. R. Club. An extended study of the effect of the length of passenger ride on street cars upon the net return on the investment in street railway properties is being conducted; it is expected that this study will require about 5 years, during which time the revenues, expenses, and traffic data of the street car systems in a number of the large cities will be analyzed. An analysis is being made of the delivery service of a large department store in New York City, with the object of presenting information upon the factors affecting the operation of the delivery service of such department store; this investigation will be completed during the present summer. The experimental work now being carried on includes a study of the "skin effect" in solid and stranded conductors when carrying high frequency currents. In connection with this study, there have been developed methods of measuring at 5000 cycles per second a change in inductance of 10-8 henry or in resistance of 0.0002 ohm. The experimental work also includes an investigation which has for its object a more accurate analysis of sound waves than has yet been made. Other studies which will be taken up include (1) an analysis of core losses at tooth frequencies in electrical machinery; (2) a study of forced and free vibrations of loaded and unloaded telephone diaphragms; and (3) a study of transient electric phenomena occurring in a 750 mile artificial power transmission line. Apparatus has been developed by one of the graduate students for measuring the alternating current resistance of railroad rails at frequencies up to 60 cycles; measurements are to be made upon a number of tread and contact rails of different chemical compositions.

At the same time that this experimental work is going on, the Vail Library of 30,000 volumes is being catalogued. This fine library was recently presented to the Institute by Theodore N. Vail, president of the American Telephone & Telegraph Company.

PANAMA CANAL HYDROELECTRIC DEVELOPMENT.

The permanent supply of electric energy for the Panama Canal is generated in the Gatun hydroelectric station, at the Gatun spillway dam. The tremendous water storage in the artificial Gatun Lake, fed by the Chagres River, not only carries vessels the greater part of the way across the Isthmus on a level about 85 ft. above the oceans, and provides water for raising and lowering them gently through the Gatun, Pedro Miguel and Miraflores locks, but also affords an excellent opportunity to generate electrical energy for lighting the canal, for operating the gigantic gates and other locking machinery, and for the locomotives towing system.

Electric current will also be used for coal handling plants at both ends of the canal, for machine shops, waterworks, drydocks, and possibly in the future for hauling trains on the Panama Railroad. To insure continuity of service in case of accident, a steam-electric station at Miraflores, erected a few years ago to supply power for construction work, will be ready as an auxiliary to pick up the load when necessary.



Gatun Hydroelectric Installation, Under Construction, Showing Pipe Lines and Turbines Erected.

The complete equipment for the power and distribution system on the canal comprises the 7500 k.v.a., 2200 volt hydroelectric power plant at Gatun; the 4500 k.v.a, 2200 volt Curtis turbo-generator electric power plant at Miraflores for emergency; a double 44,000 volt transmission line across the Isthmus, connecting Cristobal and Balboa with the two power plants; four 44,000-2200 volt substations, stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power; thirty-six 2200-240 volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks; three 2200-220-110 volt transformer stations for the control boards at the locks; and stations at Cristobal and Balboa for the coal handling plants, machine shops and drydocks.

The Gatun hydroelectric plant is designed to develop the full water output when operating under an effective head of 75 ft. Water is taken from Lake Gatun through passages 12 ft. wide, fitted with wrought iron racks 29 ft. 7 in. high to prevent trash from entering the pipe lines. The water is admitted into the pipe lines through three 10 ft. 6 in. diameter head gates, electrically controlled and operated.

The Turbines.

The three 2000 kw. main generating units in the hydroelectric station are each driven by a special, 50 in., vertical, single runner, Francis turbine manufactured by The Pelton Water Wheel Company. Each turbine has a maximum capacity of 3600 h.p. when operating under an effective head of 75 ft. and at a normal turning speed of 250 rev. per min. The turbines are located at such a height that the center of the runners is 20 ft. above tail water.

The water is discharged through steel lined concrete draft tubes, which are 71 in. diam. at the discharge from the runners and increase to an elliptical section of 9 ft. by 7 ft at the outlets, which are horizontal, there being a 90 degree bend in the tubes. The linings are made of ¼ in. steel plates, which were fitted together in the shop and shipped knocked down.

The turbines are of the spiral case type and are fitted with heavy cast iron distance rings which carry the generators. The weight of the revolving parts of each generator and turbine is carried on a roller thrust bearing mounted on top of the generator. The turbine is so designed that the runner exerts an upward thrust of 20,000 lb. when working at full capacity, thereby relieving the thrust bearing of that amount of load.

Oil for the thrust bearing is supplied by a small pump geared to the main turbine shaft, and a tank is provided below the pump to receive the overflow from the bearing. In this way a constant circulation of oil is maintained. As this oil returns to the suction tank, it passes through the lower guide bearing on the main shaft and lubricates it.

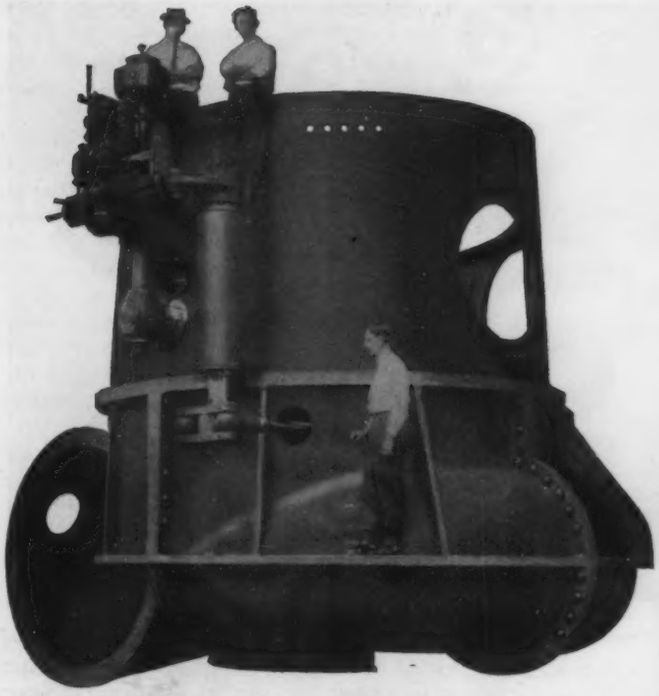
The runners of the turbines are made of a special bronze and weigh approximately 7000 lb. each. They are bored taper and held in place on the lower end of the shaft by means of bronze nuts. The surfaces of the runner vanes are all hand finished to reduce hydraulic losses.

The Governors.

The speed of the turbines is controlled by Pelton oil pressure governors, which are mounted on the distance rings and are driven by bevel gearing from the main shaft. Tachometers are mounted above the governors on supports bolted to the distance rings. The tachometers are directly connected to the governor heads.

The governors are fitted with small electric motors for varying the speed of the main units for synchronizing purposes, and a device is provided on each governor for varying the permanent drop in speed from no load to full load. This can be adjusted for any variation from 5 per cent drop to absolutely constant speed from friction load to maximum load. The governors are also fitted with hand control mechanism for adjusting the gates independent of the oil pressure.

The wicket gates for controlling the supply of water to the runner of the turbine are steel castings with hand



3600 h.p. Pelton Water Wheel Company Francis Turbine for Panama Canal Hydroelectric Station at Gatun Spillway.

finished surfaces. Each gate has its pivot stem extended upward through a packing gland and is fitted with an operating lever. All the gate levers are connected to the gate ring by means of bronze links, and the gate ring is connected to the governor rockshaft. All the regulating mechanism is therefore outside the turbine case, except the gates themselves. The water passages on each side of the gates are provided with renewable rolled steel wearing plates.

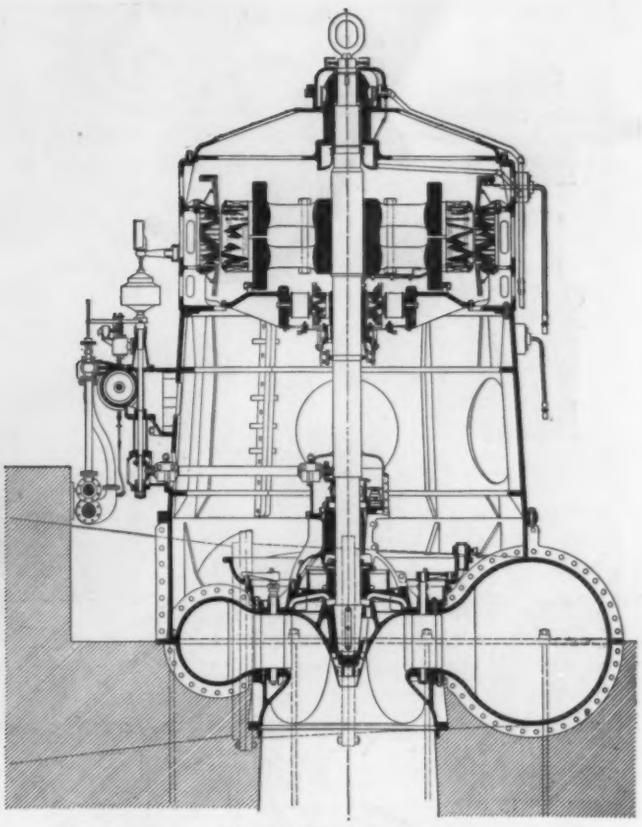
The pressure oil for actuating the governors is supplied by two Pelton rotary pumping units, driven by 10 h.p. alternating current motors at a speed of 375 r.p.m., each pump being capable of supplying the governors on all three units. The governors work on an open system, there being no vacuum chambers used. The discharge oil from the governors is led into oil sump tanks, from which it passes into the suction of the pumps. Each oil pump is connected to a steel pressure oil receiver with an air space above the oil. The oil sump tanks and pipe connections are installed in duplicate and valves are provided to enable one set to be cleaned while the other is in service.

Generators and Direct Connected Exciters.

The three main generating units are of the vertical revolving field type, each being provided with a direct connected exciter. The generators are of the General Electric Company manufacture and are three-phase, 25-cycle, with a guaranteed continuous capacity of 2000 kw. at 0.8 power factor, 2200 volts, 250 revolutions per minute, and with an overload rating of 2500 kw. at 0.8 power factor for two hours.

The exciters are of 50 kw. capacity at 125 volts, each capable of furnishing exciting current for two generators under maximum guaranteed load. Each unit, generator and exciter, weighs approximately 65 tons.

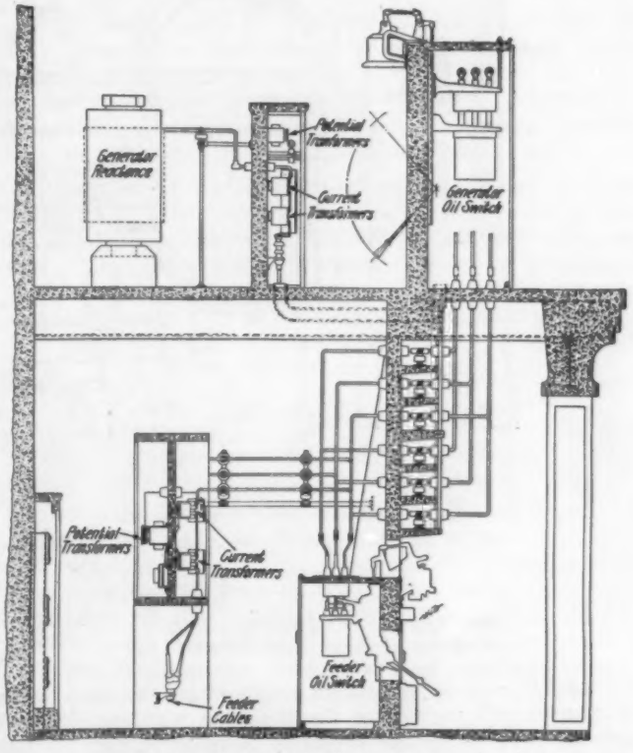
The generators, under official tests, showed an efficiency of 95.1 per cent at 2000 kw., 0.8 power factor; 94.3 per cent at 1500 kw., 0.8 power factor; and 92.5 per cent at 1000 kw., 0.8 power factor. The guaranteed temperature rises of 40 degrees C. above room temperature, of 25 degrees under continuous operation at full load and 55 degrees



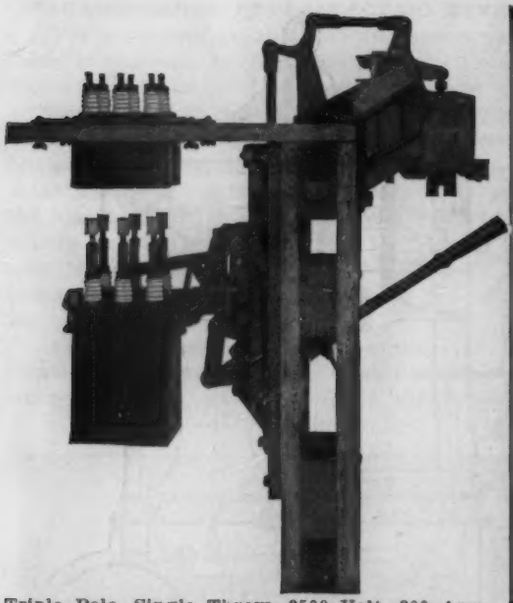
Cross Section Through Waterwheel, Generator and Exciter, Gatun Hydroelectric Installation, Panama Canal.

rise after two hours run at 25 per cent overload, were met with an ample margin.

Current limiting reactances were provided to give 5 per cent reactive drop, at 2500 k.v.a., 2200 volts, 3-phase, 25 cycle. While the generator windings are sufficiently rigid

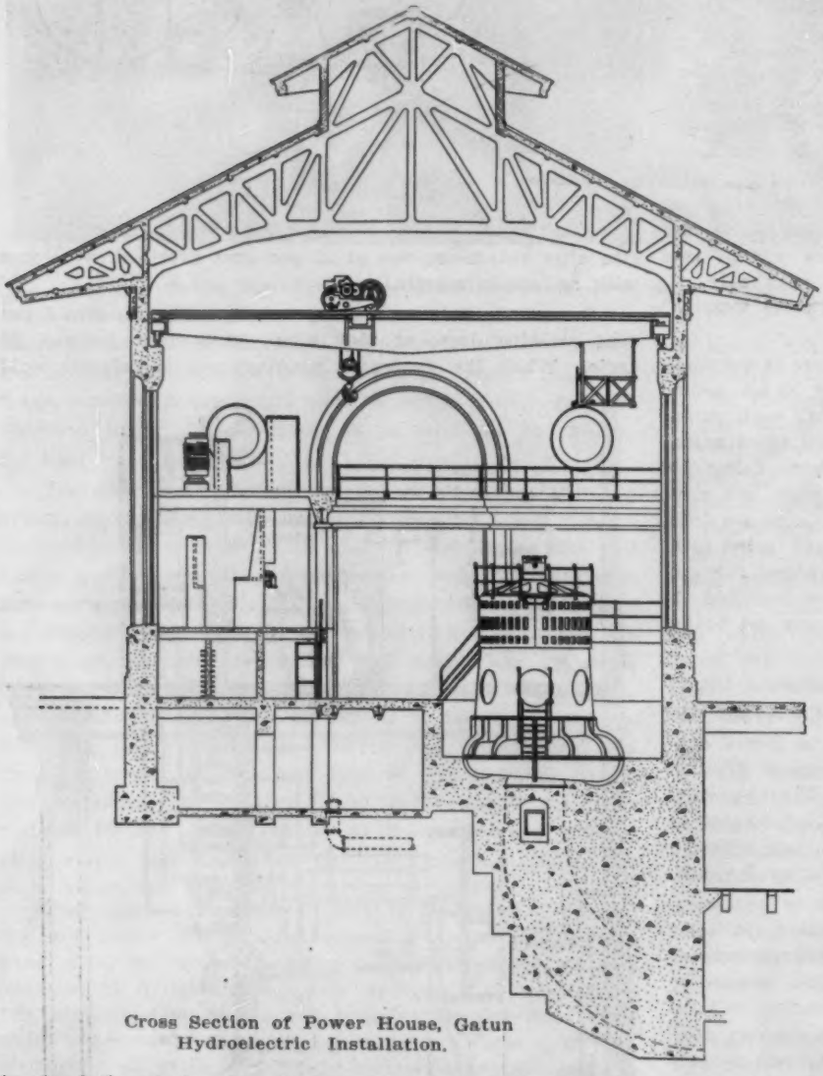


Arrangement of Switching Apparatus in Gatun Hydroelectric Station.



Triple Pole, Single Throw, 2500 Volt, 300 Amp. Oil Switch With Solenoid Operated Mechanism and Disconnecting Device Open.

Interior of 6000 kw. Gatun Hydroelectric Station.



Cross Section of Power House, Gatun Hydroelectric Installation.

to stand the strain of a short circuit under full load, these reactances will reduce the shock on the windings and will also serve to render the operation of synchronizing the machines easier and safe.

In addition to the direct connected exciters, two motor driven exciters are supplied. These consist of a 100 kw., 125 volt, 500 r.p.m. generator, direct connected to a 150 h.p., 2200 volt, 25 cycle, squirrel cage type, induction motor. They are mounted on a common base plate and provided with three bearings. These exciters can also be used for charging the control battery.

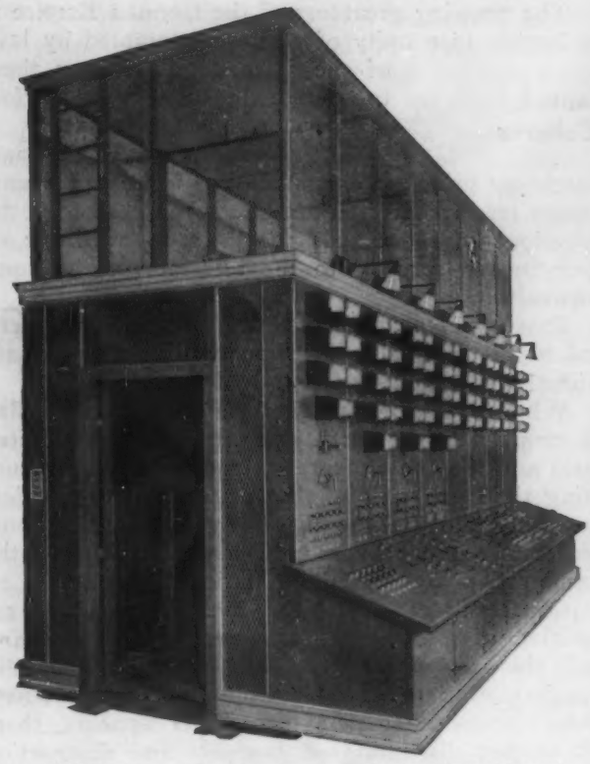
Distribution Scheme.

On account of the great distance, the current is transmitted at a voltage of 44,000 from the power stations to both ends of the canal. The step-up transformers are, however, not located in the power plants, but in substations in their vicinities; therefore, the power plants generate and distribute only 2200 volt current.

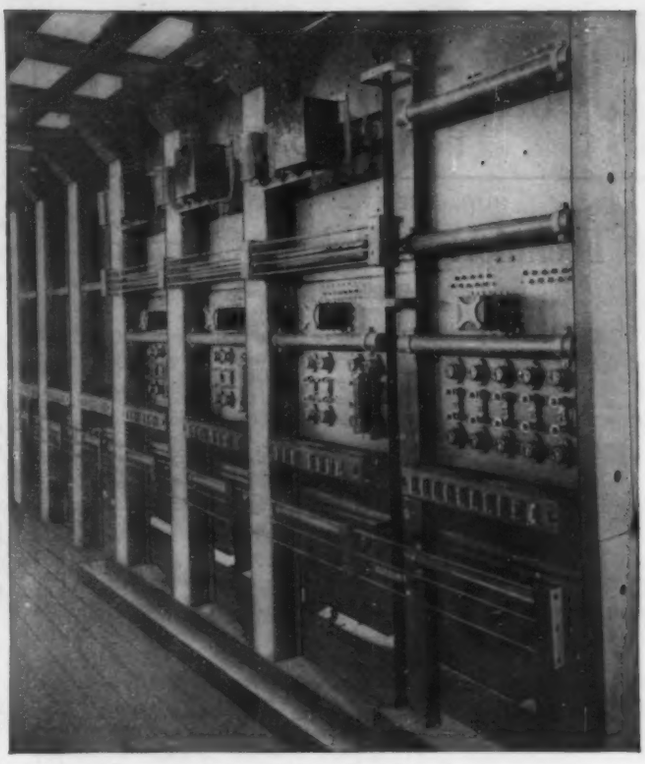
The system of connection throughout is the double bus, double switch scheme, with provision for disconnecting any oil switch for cleaning or repairs without interrupting the circuit. This system was naturally selected for this station because it was considered the most flexible for the requirement of uninterrupted service, which the engineers of the Isthmian Canal Commission have so carefully considered, though without superfluous complications.

Instrument and Control Board.

The main switchboard is of the benchboard type, with vertical rear board for relays, watthour meters, graphic instruments and the control battery equipment. The switchboard and all control apparatus were built by the General Electric Company. The space between the front and the rear boards is enclosed by grille work with doors at both ends, and a metal moulding extending along the floor and the top of the board gives a finished appearance to the whole. On the top of the switchboard is a second story, for the electrically controlled generator and exciter rheostats, accessible by means of a ladder inside the structure. The first panel from the left in the benchboard controls the ex-

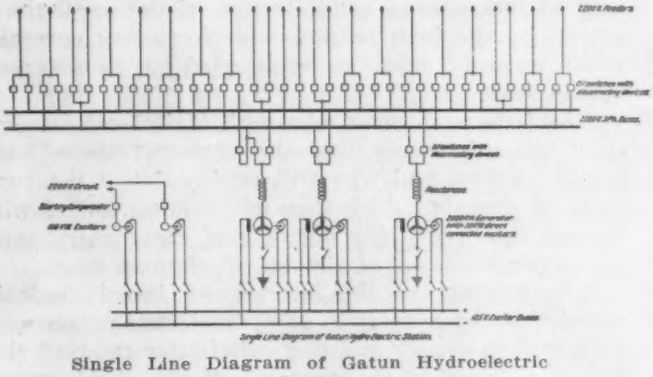


2200 Volt a.c. Instrument and Control Benchboard in Gatun Hydroelectric Station.



Interior of 2200 Volt a.c. Benchboard in Gatun Hydroelectric Station.

citers, the next three the generators and the remaining four the twenty-four feeder circuits. The system of connection is represented by dummy busses of polished copper on top of the bench. The interior view of the benchboard shows the arrangement of operating busses and fuses, potential busses, instrument resistances, and the channel iron risers with distributing tubes, which carry the instrument and control leads to their points of connection on the board.



Single Line Diagram of Gatun Hydroelectric Station.

A generator voltage regulator, transferable to either of the two sets of busses, is installed on a separate pedestal which also carries the synchronism indicators and clock.

As mentioned above, the exciters are controlled from the benchboard, but the electrically operated exciter switches and field switches are mounted on a separate board located so as to make the exciter connections as short as possible. This arrangement eliminates the exciter busses and the main connections from the control board, but leaves the control of the whole equipment in the hands of the operator.

Bus and Switch Compartments.

The bus and switch compartments are located on two galleries. On the upper gallery are located the control board near the end of the station that may be extended, the generator reactances, compartment for generator current and potential transformers, and the generator oil switches. From the oil switches, connections are made through the floor to the busses on the gallery below, on which gallery are also the feeder oil switches, and the compartment for the instrument transformers and cable bells. On the main floor just below this gallery is the cable vault with racks for the feeder cables.

All compartments are built of concrete with flame-proof doors. The busses and connections are made of solid copper rods of sufficient size to give a rigid construction even where the current is very small. After installation, the busses and connections and all joints are heavily insulated with varnished cambric to make them perfectly safe.

All the 2200-volt oil switches are solenoid operated and are provided with mechanism for readily disconnecting them for cleaning or repairs, all live parts being completely covered. The same form of disconnecting switch with slight modification is used for the hand-operated and the solenoid-operated switches. This is shown in the accompanying illustration. A mechanical interlock prevents raising or lowering an oil switch while in the closed position.

The shipping weight of the material furnished by the Pelton Water Wheel Company, including the auxiliary electrical apparatus purchased by them from the General Electric Company, was approximately one thousand tons.

The complete hydraulic equipment for this installation, including the racks, headgates, pipe lines, Pitot tube testing apparatus, turbines, governors and oil pumping units, was designed and built by The Pelton Waterwheel Company; and all the electrical apparatus, including the generators, switchboards, transformers, head gate motors, limit switches, float switches, accessories and motors for driving the oil pumps, was designed and built by the General Electric Company. The details of design and manufacture of all this apparatus were subject to the approval of the Isthmian Canal Commission's Engineers.

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POWER AND GAS

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NOTICE TO ADVERTISERS.

Changes of advertising copy should reach this office ten days in advance of date of issue. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advanace of date of issue.

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Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1900.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Wanted, a Coherer

The growing greatness of the German Empire is due largely to a unity of purpose, prompted by love of the Fatherland, causing them to cohere in an almost perfect manner.

When unification under the same thought or principle exists the connection of events is more readily detected and it is then easier for the aspirations of individuals to be made, willingly or otherwise, subservient to the interests of the commonwealth.

Proximate emoluments and honors are sacrificed to the general good though ultimately the individual also benefits.

While none will question the innate love of flag and country on the part of all citizens of the United States and the consequent existence in large measure during times of strife of that prime coherer, patriotism, it must also be recognized that unification of purpose is sadly lacking in matters pertaining to the commercial prosperity of the nation.

Coherency depends upon the existence and recognition of a common principle and purpose and until this is appreciated and the statesman big enough to declare that principle and to co-ordinate conduct under its general acceptance appears, there will be but disruption of business and destruction of common interests, although the purpose of individual though disconnected effort be never before so honest and sincere. There must be a logical consistency in administration.

Two opposite experiments in the control of business should not be allowed to be conducted at one and the same time, else how and when it is to be learned, just what is best.

In the early days of wireless telegraphy the coherer was an important part of the apparatus, necessary to the passage and detection of the oscillations set up by the high tension high frequency currents which were too subtle to be detected but by a superhuman sense.

And the statesman who with logical consistency shall bring harmony into the ranks of those who would regulate and who will readily detect the currents of thought which themselves uncontrolled will destroy the needed big business of the country, will also prove a coherer of almost superhuman sense.

A secretary of the interior of broad outlook stated that the generation of hydroelectric power was a natural monopoly and this belief later received the seal of approval in the utterance of one of the greatest electrical engineers who foresaw the realization of a nation-wide transmission system analogous to the railroads.

On every hand commissions are controlling those quasi-public utilities which give the least excuse for being considered such. This control almost invariably assures a justifiable monopoly to the corporation controlled.

Combination and monopoly in connection with the highest hydroelectric development are apparently essential.

But almost before the need for monopoly has been established or the value of commission control realized plans are proposed in order to curb this "menace" of monopolistic combination.

It is inconceivable that ihts "Banquo's" ghost of the electrical industry should be again induced to walk and while no one will question the honesty and sincerity of purpose on the part of the conservationist member of the committee on public lands now endeavoring to curb the combination of hydroelectric development interests, it must be conceded in view of the foregoing discussion of the situation, that the time is immature and the action proposed not in agreement with other endeavors to accomplish the same end.

There is a need both for coherency and the coherer.

In the German Empire, a successful outgrowth of the practice of this principle of coherency is the encouragement of big business, for combination though deservedly benefitting a few in larger measure is also seen to be conducive to the general good.

When men fail to observe the logical order and connection of events unification is destroyed, the ghost of disruption appears and Hamlet's classical statement regarding the state is seen to be still true.

A Unified West

The individual's pursuit of self is always unsatisfactory, for at the end he finds that he is chasing a shadow.

Arising early he flees the dawn of co-operative effort with its superior purpose born of interest in the industry, and chases the shadow of self with seeming success until, fatigued, he sleeps through the effulgence of co-operation's noonday which would have proved to him the absurdity of his endeavor. Awakening he finds that the shadow still eludes him as the return journey again degenerates into a chase of selfish interest until the shadow finally merges into the falling darkness, and is lost.

Preparedness alone will permit profit and each must appreciate his relationship to the rest in order to enjoy the utmost good.

This then is a plea for participation.

With such a wealth of gas and electrical engineering and allied association conventions being held at San Francisco during 1915, conventions of international in addition to those of national importance, it is essential to at this time review the state of preparedness of the Pacific Coast to the end that the utmost benefit to the various industries and their branches, be derived from these events.

It would be disappointing indeed to have visitors to the Coast return whence they came with the idea that 1915 was but a boom year here in engineering affairs, and that the world-breaking feats, of which all are so justly proud, are but the grand-stand plays of individuals forced to the issue by the necessity for coping with them.

At that time there must be present the solidarity of purpose and the complete and impenetrable front of a unified West.

This is the bending moment in our experience and the supreme test of the interpretation of this spirit of getting together or co-operation, and no matter how remote one phase of activitiy in any industry may be from any other in the same industry, all are interdependent and should work together to a common end.

The porcelain primary fuse plug is a plain and seemingly insignificant link judging from its appearance on the pole, but if put out of service it is found to be of greater importance to the success of all than is the ornate lighting glassware or the nickel plated appliance. The opposite argument also holds good and this interdependence exists in all industries.

Recognition of this should be followed by a willingness to participate.

Company sections, locals, and geographic sections of all associations should this year have such an increase in membership that no one will be excluded.

Then will exist a still greater opportunity for the formation of that main Pacific Coast organization which shall co-ordinate the efforts of all these to the end of more effective action in matters of local interest and of a unit participation in the activities of national organizations.

Strengthening the Sales Force

The sales force of any institution is composite, being partly advertising, partly inherent value of the thing sold, and partly salesman.

Consideration of the second factor would be too wide a subject to discuss in an editorial, as is also the case with the other two factors, the strengthening or most efficient utilization of which constitutes two separate, though closely associated, sciences.

It is possible though, to make a suggestion which if adopted will, by closer team-work between the factors first and last mentioned, result in strengthening the sales force and in furthering its effectiveness.

In advertising, it is elementary to say that it is profitless, figuratively speaking, to use space for the presentation of fur clothing in California, or to endeavor to interest those in zero regions in the merits of an outdoor sleeping porch.

But territorial salesmen often find that the national advertising of their firm benefits them no better than would such blunders. Their advertising entree to customers and prospects is nil, and this indicates that maximum effectiveness is not secured from advertising appropriations thus carelessly used, no matter how great the pulling power of the copy presented. At the same time the salesman is handicapped through the absence of real advertising support.

What is needed is that the salesman first write the advertising, not to the exclusion of the advertising department as at present existing, but to enlarge its service. The salesman would also benefit.

Ad-writing carried out in a conscientious, thorough and intelligent manner is one of the surest methods of learning the good points about a commodity and of what is necessary in order to make a proper sales presentation. And if the salesman is honest and sincere he will also acquire an extensive command of language and thereby learn to express his complete sales talk in a clear and concise manner.

The advertising manager will learn directly through the adoption of this plan, just what the salesman would prefer advertised in his particular territory, and this would result in the elimination of much of the present waste of words and white space in uselessly endeavoring to sell the unsuited or unsalable.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

R. Q. Clevenger of the Phoenix Glass Company is at Seattle.

H. E. Sanderson of Bryant, Perkins Company was a Seattle visitor during the past week.

I. H. McCarty has been made engineer of the Rector System of gas heating at San Francisco.

Stanley Pearce, city electrician, Sacramento, Cal., was at San Francisco for a few days during last week.

W. L. Overman, representing the Hughes Electric Heating Company of Chicago, is making a trip in Oregon.

J. NePage of NePage, McKenny & Company, Seattle, Wash., was a San Francisco visitor during the past week.

W. C. Behan of Westinghouse Electric and Mfg. Company, San Francisco, is on a trip to Lake Tahoe and Sierra region.

P. M. Longan, the new comptroller and treasurer of the Mt. Whitney Power and Electric Company of Visalia, is at San Francisco.

R. D. Power of the Nevada Electric and Machinery Company, Reno, Nevada, spent several days in San Francisco during the week.

J. E. Newlands, purchasing agent, San Joaquin Light and Power Company, Fresno, was a visitor to San Francisco during the week.

G. Douglass Jones, State Electrical Engineer, Sacramento, is conducting a series of lamp tests at the University of California, Berkeley.

Carl V. Heise, San Francisco manager Westinghouse Electric & Manufacturing Company, is spending a vacation in the Yosemite Valley.

F. J. Cram, sales manager, Electric Appliance Company, San Francisco, has just returned after a couple of weeks trip through the north of bay counties region, California.

T. E. Collins, sales manager for the Westinghouse Electric and Mfg. Company, San Francisco, returned Tuesday after a ten days' trip to Los Angeles and Southern California.

H. C. Moss, illuminating engineer at Seattle, is designing the electrical equipment for the Royal Jubilee Hospital at Victoria, B. C. The hospital will have its own plant, consisting of 2-100 kw. and 2-50 kw. turbo-generator sets.

S. K. Colby, formerly vice-president of Pierson, Roeding & Co., San Francisco, now vice-president of Allen & Peck, Inc., Baltmore, is in San Francisco with his family, and contemplates spending several months on the Pacific Coast.

C. H. Johnson, formerly with the Western Electric Company as salesman in pipe line department, has resigned to represent the C. A. Wood Preserving Company of St. Louis and has opened offices in the Rialto Building, San Francisco.

W. H. Whitson is at Fall River Mills, Shasta County, California, from Redding, and has assumed charge of the construction of the power lines of the California Power and Manufacturing Company, under Chief Engineer C. Kormel of San Francisco.

Charles T. Phillips, consulting engineer, San Francisco, gave a lecture June 22nd, before the Twin Peaks Federation of Improvement Clubs on "Street Lighting." There is a movement to better the street lighting in that district and this lecture will be given at intervals to stimulate interest.

Chas. H. Day, efficiency engineer of Altoona, Penn., gave a short talk at the University Club, Portland, Oregon, the evening of June 17th, to about 25 representatives of the various public service utilities. Mr. Day is of international reputation and his talk was greatly appreciated by all present.

T. E. Bibbins, local manager of the General Electric Company, San Francisco, is expected back from the East the early part of next week, after an absence of several weeks, during which he attended the National Electric Light Association convention and visited the company's plant at Schenectady.

J. F. Heath and **C. F. McDonald** of the Jovian Order, reached Salt Lake City last Tuesday on their around the world trip which is being made "without purse or scrip" as it were, on a bet which the boys made. They have changed their original plans which comtemplated a passage through the Panama Canal and thence eastward and are going overland. Their next stop will be at Omaha.

Wm. A. Bole has been elected by the directors of the Westinghouse Machine Company, vice-president in charge of production and erection for the plants at East Pittsburg, and at Trafford. Mr. Bole has been in the continuous employ of the company since August, 1882, having successfully filled the positions of general shop foreman, superintendent, manager of works and consulting engineer, and has therefore taken part in the growth and development of the company since it employed less than 100 men until the present, when the total forces run up into the thousands of operatives.

H. M. Byllesby, president, and **John J. O'Brien**, vice-president and general auditor of H. H. Byllesby & Company, left Chicago June 14th for an inspection of the public utility properties managed by this company on the Pacific Coast, including those in the cities of San Diego, Stockton, Richmond and Eureka, California, Tacoma, Olympia and Everett, Washington and various communities in the State of Oregon. **Otto E. Osthoff**, vice-president and chief engineer, and **Elmer Dover**, vice-president in charge of the Pacific Coast properties, will accompany them. Messrs. Osthoff and Dover are now in the West.

C. L. Cory, professor of electrical engineering at the University of California, has returned to San Francisco from an Eastern trip. While in attendance at the fortieth commencement of Purdue University, he was honored with the degree of Doctor of Engineering. This is the third honorary degree which the university has conferred, the first being upon Dr. Elwood Meade, formerly head of the Irrigation Department of the University of California, and now in charge of the Australian government's irrigation of land enterprises, and the second upon Dr. Angus Sinclair of New York City. Dr. Cory graduated from Purdue with the class of 1889, whose twenty-fifth anniversary he also attended.

James M. Barry, chief of the San Francisco Department of Electricity, called together a representative gathering of electrical contractors, workers and inspectors at a local cafe on June 23d to discuss the present electrical ordinance. This was discussed section by section, it being the unanimous opinion of those present that the ordinance as it now stands is inadequate. The subjects of an examination for contractors, the raising of the license fee and the elimination of inspection fees, and the proposition of all conduit work instead of knob and tube were also discussed during the evening. The meeting should be productive of much good in creating a better feeling and understanding among all parties concerned.

R. A. Thompson, member of the Engineering Board of the Interstate Commerce Commission, Pacific District, with headquarters in San Francisco, is preparing to take inventories and make valuations of the properties of the Western Union and Postal telegraph companies and the American Telegraph and Telephone Company. The work is to be done under the provisions of the Valuation Act of 1913. **R. W. Gray**, present district superintendent for the Western Union Company, has been appointed senior telegraphic engineer and staff officer for the newly authorized labors of the Interstate Commerce Commission. The Pacific district of the Interstate Commerce Commission comprises California, Oregon, Washington, Arizona, Nevada, Idaho, Montana, Utah, Wyoming, New Mexico, Alaska and the Philippines.

MEETING NOTICES.

Sacramento Jovian League.

At the Jovian luncheon Saturday, June 20th, a committee was named to make arrangements for holding a rejuvenation at the close of the Contractors' and Dealers' Convention on August 8th. Assurances of a large number of candidates have been given and Statesman Pearce plans a most creditable rejuvenation. The degree team is as follows:

Jupiter, G. Stanley Pearce	Neptune, J. H. Middlemess
Mars, W. C. Dolan	Vulcan, C. A. Lamas
Pluto, J. C. Hobrecht	Mercury, C. R. Gill
Apollo, R. C. Eyerly	Avrenim, L. A. Schloss
Hercules, J. C. Toby	

The Jovian Electrical League of Southern California.

Over 125 Jovians attended the weekly luncheon at Christophers on June 17th, which was presided over by C. Adolphus Renard. Among the guests who were introduced were Mr. Collins of the San Francisco office of the Westinghouse Company and Messrs. Peart and Carpenter of the San Joaquin Light and Power Company. A splendid musical program was rendered by professional talent and the Jovian quartette. A splendid address on patriotism and co-operation was delivered by the well-known woman lawyer, Mrs. Clara Shortridge Foltz, who lauded the league highly for the co-operative spirit displayed by its members.

Utah Light & Railway Company Section N. E. L. A.

The employes of the Utah Light & Railway Company held its first summer outing which was the final regular session of the winter season at the beautiful Pinecrest Inn at the head of Emigration Canyon which is reached by the electric line of the Emigration Canyon Railroad Company. The 150 employes and ladies left the city on the 2:30 train and spent the balance of the afternoon tramping over the hills and resting in the countless shady nooks which make this mountain resort so pleasurable. At 6:30 p. m. the company sat down to the celebrated trout and chicken dinner served by the Pinecrest Inn. At the conclusion of the dinner short toasts were responded to by G. B. Walker, Wm. Scott, and A. W. Milgate. F. A. Keyworth acted as toastmaster. Mr. Lloyd Garrison read the Company Section "Gimlet," which contained numerous jibes on the various company employes. Hy. C. Dunbar, the popular comedian from the line and service department, provided his usual fund of amusement. At the conclusion of the dinner the following officers of the Company Section were elected for the ensuing year: President, A. E. Kennelly, lines and service department; Vice-president, W. E. Turner, engineering department; Secretary and Treasurer, E. C. Cathcart, storekeeper. The party then adjourned to the hotel ball room where dancing was the order of the evening until the return of the special train.

Los Angeles Section Electric Vehicle Association.

With the object of promoting the use of the electric vehicle in Southern California, for both business and pleasure, prominent men interested either directly or indirectly on last Friday evening organized the Los Angeles section of the Electric Vehicle Association of America. The new organization was launched with a membership of thirty-one, and will hereafter hold meetings each month. One of the first objects the new association will seek will be the establishment of adequate electric charging stations in every important town in Southern California in order that the range of usefulness of the electric vehicle will be greatly extended.

The following are the officers and members of the new organization: Chairman, J. Harry Pieper, Southern California Edison Company; Vice Chairman, Harry W. Harrison, General Vehicle Company; Secretary, James F. Rogan, Edison Storage Battery Company. Executive Committee: G. B. McLean, Pacific Light & Power Corporation; A. T. Smith, Firestone Tire & Rubber Company; J. O. Case, General Electric Company; Harry J. Kister, Los Angeles Gas & Electric Corporation; Earl C. Anthony, California Motor Company; I. R. Solomon, Gould Storage Battery Company; Charles Carter, Pacific States Electric Company; Volney S. Beardsley, Beardsley Electric Company.

Members: John B. Miller, Southern California Edison Company; S. M. Kennedy, Southern California Edison Company; J. Harry Pieper, Southern California Edison Company; C. P. Houghton, Los Angeles Gas & Electric Corporation; H. J. Kister, Los Angeles Gas & Electric Corporation; J. F. Rogan, Edison Storage Battery Company; H. W. Harrison, General Electric Company; Volney S. Beardsley, Beardsley Electric Company; John D. Shannon, Beardsley Electric Company; I. R. Solomon, Gould Storage Battery Company; R. H. Morris, Electric Car Exchange; A. T. Smith, Firestone Tire & Rubber Company; Earl C. Anthony, California Motor Company; Charles Carter, Pacific States Electric Company; W. F. Rath, Electric Storage Battery Company; C. H. Kay, Kay & Burbank, Pasadena, Cal.; A. C. Kendall, Kendall Auto Company, Pasadena; J. O. Case, General Electric Company; W. E. Kerrick, Wilshire Auto Company; C. B. Lamoree, Westinghouse Electric & Mfg. Company; A. H. Sweetland, National St. & Sta. Ind. Co.; T. E. Felt, 1837 West Thirty-eighth street, Los Angeles; R. R. Thomas, Electric Equipment Company; Carl Klemp, California Electric Garage; A. S. Morton, California Electric Garage; E. R. Davis, Pacific Light & Power Corporation; G. M. McLean, Pacific Light & Power Corporation; A. W. Harrison, Los Angeles Creamery & Auto Company; E. B. Moore, Los Angeles Creamery & Motor Company; S. S. Wilder, Kendall Auto Company.

Annual Picnic of the Jovian Electrical League of Southern California.

At the annual picnic of the Los Angeles Jovians between 600 and 700 loyal Jovians, their families and friends journeyed by autos and special trains to beautiful Verdugo Park, and from early morning until the sun had set it was "all together, all the time, for all the fun and sports." And plenty of each there were, furnished by the highly efficient committees, from the baseball game in the morning to the dancing and awarding of prizes before "going home" time.

The ball game between the manufacturers and jobbers against the power companies and contractors was played at high pressure, so that the final score was 1 to 0 in favor of the manufacturers and jobbers, whose bats offered considerable resistance to the balls passing between their opponents' batteries. The decisions of Umpires Francis and Woodill required frequent transformation and considerable good-natured reaction was evident at times.

After this heated contest, everyone adjourned to the well-shaded grove, where boxes and baskets were opened by the score and emptied by the hungry crowd, who were treated to ice cream, coffee and "soft drinks only" by the league. A panoramic photograph of the multitude was then taken with the high Sierras as a background and then the program of athletic contests was begun. It having been announced that prizes aggregating $300 would be offered, there were many entries for each event, and it has been stated that some national records were broken or at least equaled.

Dancing was indulged in for many hours, splendid music being furnished by a band brought from the city. Much credit for the success of the picnic is due to the officers of the league and special committees, appointed by Chairman Colkitt. They were as follows:

Executive committee—G. E. Arbogast (general chairman), A. B. Day, F. J. Airey.

Transportation committee—J. C. Rendler (chairman), W. A. McNally, O. D. Harris.

Publicity committee—H. W. Allen (chairman), R. J. McHugh, E. A. Taylor.

Sports committee—C. E. Spaulding (chairman), E. B. Clay, L. E. Darrow.

Prize committee—P. C. Reed (chairman), G. H. P. Dellman, F. E. Lehman.

Finance committee—J. E. MacDonald (chairman), J. O. Case, A. G. Drake.

Entertainment committee—J. E. Tucker (chairman), R. B. Clapp, C. B. Capps, R. H. Manahan, R. H. Sterling, J. L. Gray, C. B. Hall, E. R. Northmore, S. J. Keese, E. L. Lewis, R. B. Rawls, H. B. Lynch, W. J. Gracey.

It is of interest to note, to give further evidence of fraternalism, that on the day of the picnic every electrical concern in Los Angeles closed its doors.

CALIFORNIA ASSOCIATION OF ELECTRICAL INSPECTORS

Section of N. A. E. I.

C. W. Mitchell, President. Arthur Kempston.
Wm. G. Pennycook, Vice-Pres. B. C. Hill, Executive Comm.
John W. Carrell Secretary-Treasurer, 55 Fulton, San Francisco.

The purpose of this organization is to standardize the common practice in electrical construction with the National Code as the general standard.

Questions pertaining to electrical construction will be answered in these columns, but only from the point of view of the Code. This is a voluntary organization and the answers published under this heading must not be construed as authoritative, or binding. No attempt will be made to correllate the answer from the several Inspection Districts, as an occasional difference of opinion will tend to induce further study on subjects. All questions will be passed upon by an executive committee.

Address all communications to the secretary.

By the Secretary.

The C. A. E. I. held their June meeting in San Jose Saturday afternoon, the 20th. The subject was Centers of Distribution. Those in attendance were C. W. Mitchell, Underwriters; Wm. G. Pennycook, Arthur Kempston, J. W. Carrell, San Francisco; B. C. Hill, T. A. Ellison, P. A. Anderson, Oakland; S. G. Pierce, Sacramento; F. M. Miller, Fresno; Jas. I. Dixon, Santa Clara; W. A. Spencer, San Jose. Mr. Dixon of Santa Clara has achieved the distinction of being the first city electrician to arrange his automobile fire apparatus to be started from the central fire alarm station.

The following is the correlated result of discussions on main service wiring, subject to further revision for precision and clearness:

Main Service Wiring.

Definition: In so far as these interpretations apply the term main service wires shall mean all wires in or on buildings or structures, extending from the place of connection to the source of supply to the main service cut-out and switch.

Interpretation of Rule 23, Section A.

Cut-Out Locations: The service cut-out must be located at the nearest accessible place to the point where the wires enter the building; that is, at the nearest point where the rules for the location of cut-outs can be complied with. In buildings supplied from underground the service cut-out must be located at the place where the wires protrude through the basement wall; where basements are not accessible this cut-out must be located at the nearest place where the rules for location of cut-outs can be complied with to a line vertical to the point where the wires project from underground.

For buildings supplied by overhead wires the entrance cut-out may, if all the service wires are enclosed in conduit embedded for the entire wiring distance in fire-proof construction, be located at any desired place where the rules for installation of cut-outs can be complied with. Where service wires are protected by cut-outs placed in a hood or cabinet at the outer end of the service conduit (as in cases where conduit enclosing service wires is concealed in non-fireproof construction) the hood or cabinet must be located near a window of the second story or in a place of equivalent accessibility so as to permit of easy inspection or replacement of the fuses; in this case the fuses may be of the rating allowed by Rule 18 for other than rubber insulation but an additional cut-out located inside the walls must protect the main service wires in accordance with Rule 18 for rubber insulation.

Main Service Switch.

Interpretation of Rule 24, Section A.

The main service switch must be either located in, or arranged so that it may be opened and closed from one of the principal entrances of the building and in a place which is easily accessible from the street, (access to the premises is assumed). Where this switch is both in plain sight and easily accessible from one of the principal entrances this interpretation is deemed complied with.

Must be protected by the main service cut-out unless the cut-out and switch are of combination type and mounted on the same base; must be so connected that the blades will be dead when the switch is open; must be located within 7 ft. from the floor.

Wires: Must be large enough to transmit current for the full capacity of all circuits which are installed and to provide start-current for the largest motor that may be connected to the system. In the case of lighting circuits, this means at least six amperes for each circuit which is installed.

The neutral of a three-wire system must have a safe carrying capacity, sufficient to transmit current for the maximum possible load to which the neutral is connected.

Must if installed underground have an approved lead covering; but a lead covering will not be required for the grounded neutral of a three-wire system.

Conduit: Must not, if enclosing wires not protected by automatic cut-outs, be concealed in any non-fireproof construction, except that it may pass through the outer wall of a building at right angles to the vertical plane thereof, and must not be run exposed on the outside of any building for a wiring distance which exceeds thirty feet.

A FUSELESS ROSETTE.

(By H. B. Rodgers, Pacific States Electric Co.)

A key socket said to a fuseless rosette,
"I am the main works here, you bet.
All you do is stick to the wall
And hold a cord, that's all—that's all.
I turn on and off the light.
If they want it dark or want it light,
I'm the one they come to see—
Not you my boy, they come to me."
"I admire your nerve," said the New Code Cord,
"And the trust you put in the dear old Lord.
If it wasn't for this old twisted pair,
How long would you stick in the air?"
"Please put me wise," said a 40-watt,
"Where you get that Tommy rot,
Your only excuse for living, I know,
Is because I'm hanging here below."
"Your talk," said the rosette, "Is simply bunk,
When you burn out, your name is Junk.
I don't like to brag, for well you know
I have no fuse up here to blow,
But if from me you don't get fed,
The whole darn bunch of you are dead;
And so each night ere you retire
You socket, lamp and twisted wire,
Say your prayers, but don't forget
Pray, the screws hold fast in this rosette."

ELECTRICAL CONTRACTORS' NOTES

W. H. Smith Electric Company has the electric contract for remodeling the electrical installation in the Arcade Theater, Portland, Oregon.

C. N. Rierdan has the electrical contract for the installation of the electrical equipment of the new Ice Hippodrome, Portland, Oregon.

Morrison Electric Company has the electrical contract for the B'nai Brith Building Association Club House. at Thirteenth and Mill streets, Portland, Oregon.

The West Coast Engineering Company has the electrical contract for the new four story apartment house being erected by J. R. Whalen at Seventeenth and Everett streets, Portland, Oregon.

Pacific Fire Extinguisher Company has obtained the electrical contract for the building being erected by the estate of Z. W. Whalley and W. T. Muir, on the southwest corner Pine and First streets, Portland, Oregon.

NEWS NOTES

INCORPORATIONS.

SAN BERNARDINO, CAL.—The Watervale Water Company of Victorville, capitalized at $26,200, has filed articles of incorporation. Reginald Frost, E. E. Richardson and W. W. Richardson are named as directors. Victorville is the principal place of business.

TUCSON, ARIZ.—The Silver Lake Water Company has filed articles of incorporation with a capital stock of $350,000, the incorporators being Gustave J. Magenheimer, Chicago, Ill.; Parl F. Magenheimer and Harry Hughes, Tucson, Arizona. The principal place of business is Tucson.

SAN DIEGO, CAL.—The Perfect Protection Telephone Company has been organized with a capital stock of $50,000, to market a sanitary telephone mouthpiece. The incorporators are Josephine A. Hall, S. M. Hall, Sarah E. Swisler, F. F. Johnson, and S. K. Johnson, all of San Diego.

SAN DIEGO, CAL.—Articles of incorporation have been filed of the Bay Shore Railroad Company, capitalized for $200,000, to build a railroad from the Ocean Beach terminus of the Ocean Beach Railroad across the inlet of False Bay and along the peninsula to a point near La Jolla. The incorporators are Chas. W. Fox, Geo. L. Barney, Gordon Decker, John F. Forward Jr., and J. H. McKie. The capital stock is divided into 2000 shares of $100 each. The proposed improvement will include the construction of an electric way, of a boulevard along the peninsula and bridging of False Bay.

ILLUMINATION.

SAN JOSE, CAL.—The Willow Glen lighting district adjoining San Jose on the southwest was formed recently by a special election.

MONROVIA, CAL.—The Pacific Light & Power Corporation has been granted a franchise to operate and maintain electric pole and wire system in the town of Arcadia.

EUREKA, CAL.—The Western States Gas & Electric Company has been granted a franchise for stringing wires and placing poles along the county road on Table Bluff from Perrott's ranch to Singley's station.

RAYMOND, WASH.—The county commissioners have granted to W. P. Cressy of South Bend a 25 year franchise to lay pipes and mains for the distribution of gas in all highways of the South Bend Land Company's Addition, Hyde Park Addition and territory lying between South Bend and Raymond.

OGDEN, UTAH.—Upon the recommendation of the city engineer the board of city commissioners authorized the extension of the "white way" to include three more streets in the business district of Ogden. The engineer was ordered to take the matter up with the Utah Light & Power Company, the Ogden Rapid Transit Company and the Webber Club immediately. Lights will be placed on steel poles on both sides of Twenty-fourth street between Washington and Wall avenues, on Grand avenue between Twenty-fourth and Twenty-fifth streets. When this work has been completed all streets within the business district will be lighted by the modern system.

TRANSMISSION.

TACOMA, WASH.—An ordinance has been passed providing for the Seattle Tacoma Power Company to place all electric wires in underground conduits.

NOGALES, ARIZ.—Announcement has been made by the Nogales Electric, Ice & Water Company that it will in the near future commence the erection of a new power plant just north of the big foundry and machine shops on Grand avenue.

LOS ANGELES, CAL.—The city council has authorized the engraving of $1,482,000 of power bonds and the repealing of the resolution adopted some weeks ago. The new resolution provides for paying off of the bonds (first) on August 1, 1914, instead of 1915, as per the first resolution.

EL DORADO, CAL.—The California Mining & Dredging Syndicate, operating the Shaw mine at Eldorado, are installing electrical equipment throughout. A two mile transmission line to connect with the lines of the Western States Gas & Electric Company and a transformer station are being installed by Bendel & Bendel of Oakland.

EUGENE, ORE.—C. A. Elkins and Frank Shelley of this city, have been awarded the contract by Richard Clow to erect and install a hydroelectric plant on a small creek near the town of Mapleton for the generation of electric power and light for that place. The creek will be dammed by a solid wall of concrete and the water will be conveyed to the turbine through a 12 in. pipe line 2000 ft. long. The water will have a fall of 100 ft. in that distance.

ABERDEEN, WASH.—C. E. Troutman has returned from Raymond and Southbend and states that the Willapa County Traction Company, Frank McKean of Seattle, president, is a factor of the Mason County Promotion Company and other corporations which have for their object the electrifying of all logging operations in Pacific, Chehalis and other counties, and in the developing of water power. According to a statement by Mr. McKean, the company owns rights at the headwaters of the Wynooche river and proposes to develop them.

LEHI, UTAH.—The power plants of the Utah Power & Light Company in this immediate section of the state, representing an outlay of more than a half million dollars, are rapidly being closed up and may remain idle for an indefinite period. The electric plant at Battle Creek, costing $150,000 has been closed for two months. The one at Alpine, costing $175,000, has also been recently closed down. The one at the mouth of American Fork canyon and the one two miles up in the canyon will be out of commission after July 1st. The four plants have a total capacity of more than 5000 h.p. The closing of the plants does not mean that the electric light and power service of this locality will be impaired in any manner, but that it is a policy of retrenchment being instituted by the power company. When the present owners formed the Utah Power & Light Company they took over twenty-four plants which had been built by almost as many companies. Each of them had a surplus of power, and when the amalgamation was perfected there was a vast aggregate of power that was not needed. As fast as the market for electrical energy is developed, the plants will be again placed in operation and it will not, therefore, be the policy of the company to sell or dispose of any of the closed plants. On the contrary, they will be kept in perfect condition, so that as they are needed, either for emergency purposes or for permanent use, they will be ready.

TRANSPORTATION.

SAN FRANCSICO, CAL.—H. S. Tittle has been awarded the contract for furnishing and installing overhead electrical conductors for the municipal railway line on his bid of $36,245.

OAKLAND, CAL.—Plans are being figured for a three story and basement class A railroad office building at Twenty-second and Grove streets, to cost $50,000, for the San Francisco-Oakland Terminal Railways, by Architects Milwain Bros.

SALT LAKE CITY, UTAH.—The Westinghouse Electric & Manufacturing Company commenced this week on the in-

stallation of electric equipment for the new Orem Interurban Electric Line to Provo. This work is in charge of W. A. Davis, installing engineer for the company.

OGDEN, UTAH.—The contract for building the electric railroad that will connect Ogden with Brigham, Logan, Lewiston and Preston, Idaho, has been let to the Utah Construction Company, according to an announcement made by P. D. Kline, general manager of the Ogden Rapid Transit Company.

SALT LAKE CITY, UTAH.—The Utah Light & Railway Company is preparing plans and specifications for an addition to its car barns to house the twenty-four new interurban cars which the company has on order and which will be delivered in the course of the next thirty days. The addition will cost $50,000.

SEATTLE, WASH.—Extension of the Lake Burien street car line, owned by the city, to the beach at Three Tree Point on Puget Sound, a distance of about two miles is a probability, if the plans of several large property owners between the present terminus and the Sound are carried out. These owners propose to build a line from Lake Burien to the beach and deed it to the city.

OGDEN, UTAH.—Plans are now under way for the consolidation of the Ogden Rapid Transit Company which operates the transportation system in Ogden, with the Logan Rapid Transit Company which operates the street car system in Logan. Construction work is already in progress on the interurban extension of the Ogden Rapid Transit Company's line from Ogden to Logan, a distance of 65 miles, the purpose of the consolidation being to have a unified system operating in the two cities and on the interurban connection when this is completed.

SAN FRANCISCO, CAL.—The San Jose Terminal Railroad, which is planning a new transportation line into San Francisco from the south has applied to the harbor commissioners for a terminal dock, stating that the construction of the electric line between San Jose and Alviso, a distance of 11 miles is now under way and that it is expected that it will be completed and ready for the intervening water service of 40 miles by January 1st of next year. The request was referred to the committee of the whole with the intimation it would be granted as soon as more definite information about the space desired and time of occupancy, is received.

SALT LAKE CITY, UTAH.—The city commissioners on the 18th of June granted to the Utah Light & Railway Company a 41 year franchise to haul express and mail matter over certain of its city lines designated in the franchise in order to reach a central freight and passenger depot contemplated by the company. This company has been extending its interurban lines south to Midvale, Murray and Sandy, southeast to Holliday and north to Bountiful, Centerville and Farmington during the past four or five years. These lines pass through a rich agricultural section which is devoted almost exclusively to extensive farming and truck gardens but the company has not been able to give these residents along their lines the benefit of the freight and express service which has done so much to build up interurban territory in other localities, on account of the persistent refusal of the city authorities to grant them a freight and express franchise. The present franchise was only obtained after many of the features which would have made it of greatest benefit both to the rural and city population had been eliminated. The company officials believe, however, that when the public have an opportunity to see the benefit derived from the operation of this system, that they will be able to secure an extension of their privileges along the lines of the features stricken from the franchise which runs for a period of 41 years and expires with the company's general franchises.

TELEPHONE AND TELEGRAPH.

OAKLAND, CAL.—The compromise between the city of Oakland and the Pacific Telephone & Telegraph Company upon the latter's acquisition of the Home Telephone Company was made effective by the passage of the necessary resolutions by the city council. Under the agreement the company will not forfeit the $100,000 which was to have been paid to the city in the event of the sale of the Home company. The purchasing company takes over the Home company franchise, which increases the life of its franchise grant of 13 years. Under the Home Company's franchise, assumed by the Pacific company, 2 per cent of the gross earnings will be paid to the city. The company also furnishes the city with 200 free phones.

SAN FRANCISCO, CAL.—The rate fixing committee of the board of supervisors has refused to sanction any advance in standard classes of telephone charges. By a readjustment of the rates the committee assured the Pacific Telephone & Telegraph Company of increased earnings that will aggregate $40,000 a year, but this readjustment will entail no increases in the standard classes of telephone tolls. The readjustment scheme abolished classes of service on which the company claimed it had not received just returns, and its increased earnings will be derived principally from the earnings that will accrue from the elimination of these classes. With the estimated $40,000 increase in revenue, the company will be receiving a return of more than 6 per cent on its investment. It received 5.75 per cent on the 1912-1913 rates, and would have received 6.90 per cent with the increases recommended by the engineers.

NORTH YAKIMA, WASH.—Arrangements were completed here recently between the members of the public service commission of Washington, in session here in the Pacific Power & Light Company valuation hearing, and Chairman Clyde B. Aitchison of the Oregon Railway Commission, for a meeting of both commissions in Portland, June 25th, with the executive officers of the Pacific Telephone & Telegraph Company. The plan includes taking steps toward fixing local, intrastate and interstate rates, and exchange rates for rural lines in Washington and Oregon, and so far as the company's lines extend into Northern California. The property investment is claimed to be as high as $90,000,000 and this is the first move toward general consideration of conditions by the commissions. The Washington commission some time ago consented to the placing in effect for experimental purposes a new schedule of rates based on air line distances. Both commissions are now working toward securing a physical valuation of the company's properties in their respective states.

WATERWORKS.

SEATTLE, WASH.—Bids will be readvertised at once by the city for the construction of the tunnel for the water mains under Lake Union, as all previous bids were rejected. The work will cost about $175,000.

PARKER, ARIZ.—The Sharp-Fellows Company of Los Angeles has taken a contract for the construction of a 50,000,000 gal. reservoir at Smith's Springs ,above Flagstaff, for the Santa Fe Railway Company. A storage dam is to be placed near Seligman in the canyon of Walnut Creek, to be connected with the Santa Fe Railway service by a 20 mile pipe line.

OROVILLE, CAL.—The irrigated area in the Thermalito orange and olive district is to be more than trebled during 1915, according to the plans of the Oro Electric Corporation, which now delivers water to about 1000 acres of land in the Thermalito district. Plans and specifications for enlarging the system to cover 3500 acres have been drawn. A. A. Davis, resident superintendent of the company, announced that the company expected to make these extensions to its system during the coming year.

MODEL 280, Single Range Portable Voltmeter. (One-quarter Size.)

WESTON

Miniature Precision Instruments for Direct Current

A new group of very small Indicating Instruments

COMPACT—ACCURATE—DURABLE—BEAUTIFUL

MODEL 280, Triple Range Portable Volt-Ammeter. (One-quarter Size.)

PORTABLE

Voltmeters, Millivoltmeters, Volt-Ammeters, Ammeters, Mil Ammeters are supplied in single, double and triple ranges.

The triple range Volt-Ammeter comprising six instruments in one.

This group also includes BATTERY TESTERS.

MODEL 267, Switchboard Ammeter. (One-quarter Size.)

SWITCHBOARD

Voltmeters Volt-Ammeters Ammeters Mil-Ammeters

This new line of instruments represents the latest development of the pivoted moving coil, permanent magnet type for low ranges.

The refinement of design and mechanical work in them has been carried to a degree which would appear to be almost impossible of accomplishment, if the results were not evident in the instruments themselves.

MODEL 268, Switchboard Volt-Ammeter. Reads Amperes. Press Button for Volts. (One-quarter Size.)

They embody characteristics which have made the well-known Weston Standards famous throughout the world.
They are accurate, dead beat and extremely sensitive.
They may be left continuously in circuit at full load without injury and are shielded against the external electrical and magnetic influences of other apparatus in their vicinity.
They are substantially constructed and may be safely sent long distances through the mails and will withstand an extraordinary amount of vibration without injury.
They have the longest scale ever provided in instruments with equal length of pointer.
Each model has been thoroughly tested under the most severe conditions of service and in experiments extending over more than one year.
The portable instruments may be conveniently carried in the coat pocket.
The prices have been established upon so low a scale that any one may possess one or more of these remarkable instruments at moderate cost.
If you cannot obtain the instruments desired from your dealer, write us.
The several models and ranges offer a selection from over 300 different combinations, listed in Bulletin No. 8. Will be mailed upon request.

WESTON ELECTRICAL INSTRUMENT COMPANY,

Main Office and Works: NEWARK, N. J.

New York, 114 Liberty St.
Chicago, 1504 Monadnock Block.
Boston, 176 Federal St.
Philadelphia, 342 Mint Arcade.
Birmingham, Amer. Trust Bldg.
St. Louis, 915 Olive St.
Denver, 231 15th St.
San Francisco, 682 Mission St.
Cleveland, 1729 E 12th St.
Detroit, Union Trust Bldg.
Montreal, Winnipeg, Vancouver, Calgary } Northern Electric & Mfg. Co.
Toronto, 76 Bay St.
Paris, 12 Rue St Georges.
London, Audrey House, Ely Place, Holborn.
Berlin, Genest Str. 5. Schoenberg.
Johannesburg, So. Africa, F. Peabody Rice, Standard Bank Buildings, Harrison St.

Bar Slab

Area of Steel .25

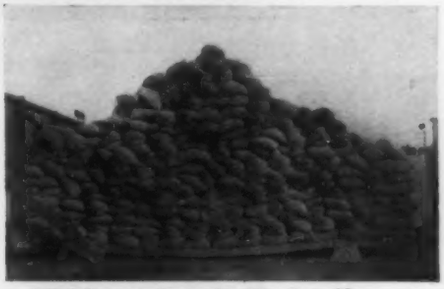
1-2 4 Concrete ⅜" sq. Bars @ 6¾" c c.
Two bars out of three bend up.
12' span—4' wide—4" thick.

Uniform Load at time of failure 35000 lbs.
Sq. Foot Load at time of failure 486 lbs.

Comparative Tests

Welded Fabric Slab

Area of Steel .18



1-2-4 Concrete long wires No. 3 @ 3" c-c.
Cross wires No. 8 @ 12" c-c.
12' span—4' wide—4" thick.

Uniform Load *without failure* 47000 lbs.
Sq, Ft. Load at center *without failure* 826 lbs.

Clinton Welded Fabric develops 100% greater strength of concrete slab than equal area of deformed bars.

Ideal Reinforcement for Flumes, Reservoirs, Etc.

ASK US FOR FULL DATA

L. A. NORRIS COMPANY

ENGINEERS

644 Monadnock Bldg. **San Francisco, Cal.**

CROCKER-WHEELER

Motors
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Transformers

Prompt Shipments from Pacific Coast Stock

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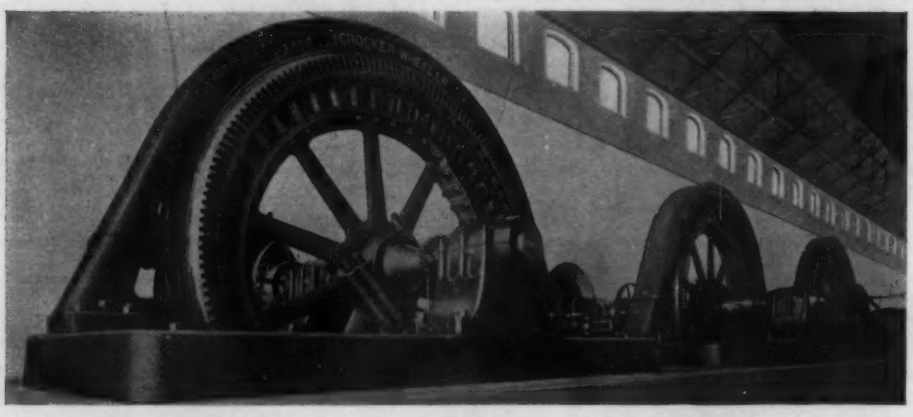
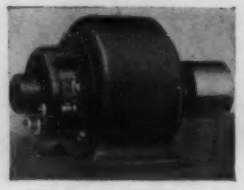


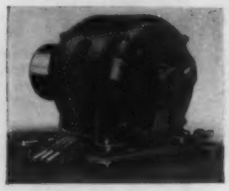
Three of Seven 4000 KVA Coupled Type Generators
Sanitary District of Chicago



Form L Motor

This motor embodies twenty-five years' experience in the manufacture of direct current apparatus. Over a million dollars worth of these machines have been sold and are in satisfactory operation today in practically every form of motor drive for which a small motor can be used.

50 KVA—3300 Volt



Form Q Motor

This induction motor is one of the most reliable electrical machines we have ever built in our quarter century of manufacturing. Area of bearings and diameter of shaft are exceptionally liberal, insuring long life and low cost of maintenance. Made in both squirrel cage and slipring form.

For List of Sales Offices and Other Information See Next Page

Send For These Bulletins and Keep Them on File

They Describe Apparatus Which Can Be Shipped On a Day's Notice From Pacific Coast Warehouses

Alternating Current Motors

FORM Q INDUCTION MOTOR for 50 and 60 cycle polyphase alternating current circuits—Standard stock sizes ½ to 100 h. p.
Bulletin 160J

FORM R INDUCTION MOTOR for 25 cycle polyphase alternating current circuits
Bulletin 141J

Direct Current Motors

FORM L MOTOR—Standard Stock sizes 1/20 to 7½ h. p.
Bulletin 159J

FORM I MOTOR—Standard Stock sizes 7½ h. p to 50 h. p.
Bulletin 161J

FORM H MOTOR—Standard Stock sizes 50 h. p. and larger
Bulletin 149J

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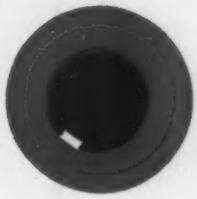

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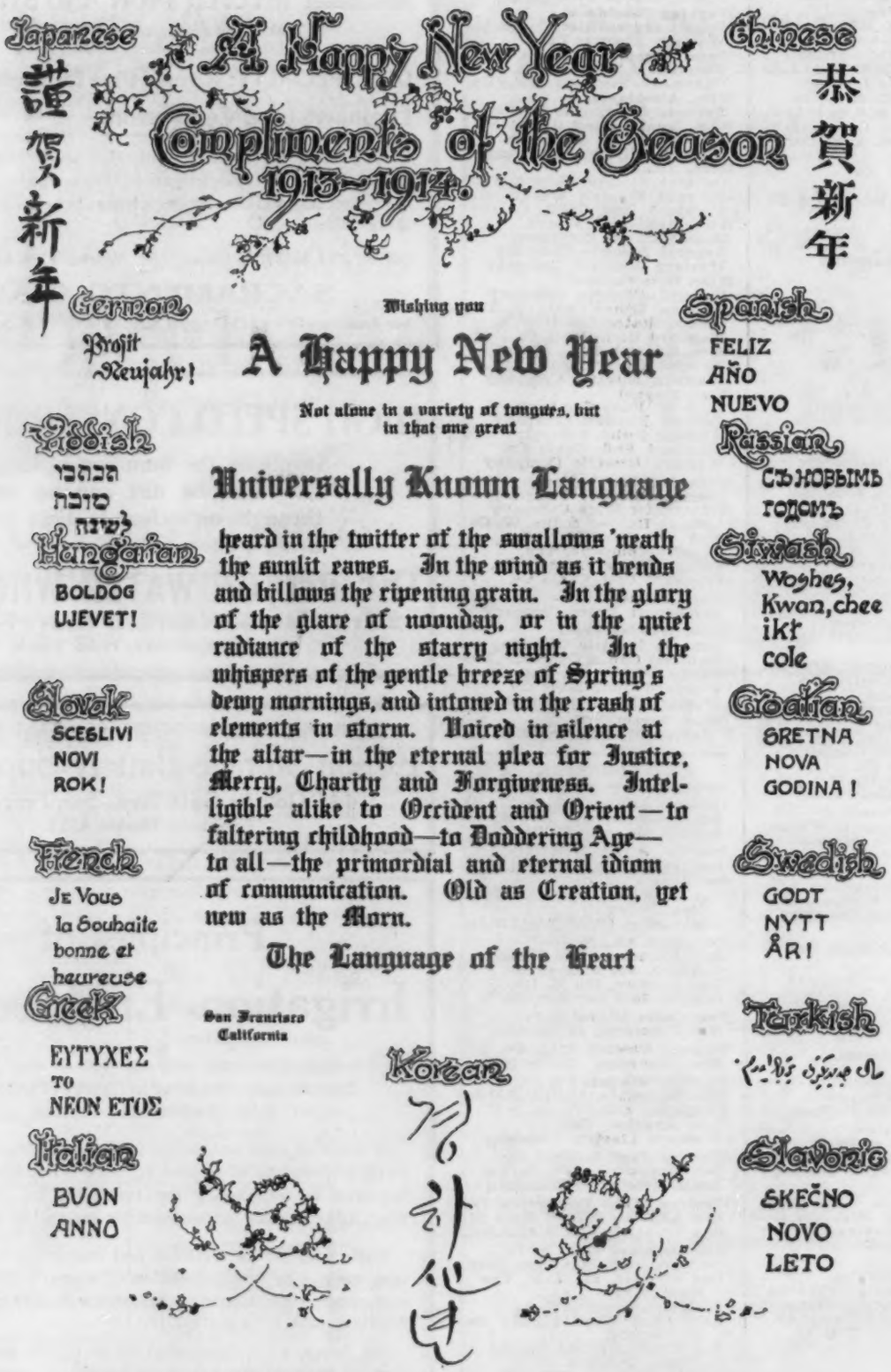
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